

A COLLECTION OF FLEAS
FROM THE BODIES OF BRITISH BIRDS

WITH NOTES ON THEIR DISTRIBUTION
AND HOST PREFERENCES

BY

MIRIAM ROTHSCHILD



Pp. 185-232; 3 Text-figures

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
ENTOMOLOGY

Vol. 2 No. 4

LONDON : 1952

THE BULLETIN OF THE BRITISH MUSEUM
(NATURAL HISTORY), *instituted in 1949, is issued
in five series, corresponding to the Departments of the
Museum.*

*Parts will appear at irregular intervals as they become
ready. Volumes will contain about three or four hundred
pages, and will not necessarily be completed within one
calendar year.*

This paper is Vol. 2, No. 4, of the Entomology series.

PRINTED BY ORDER OF THE TRUSTEES OF
THE BRITISH MUSEUM

Issued February 1952

Price Ten Shillings



A COLLECTION OF FLEAS FROM THE BODIES OF BRITISH BIRDS, WITH NOTES ON THEIR DISTRIBUTION AND HOST PREFERENCES

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With three text-figures

SYNOPSIS

Ten species of fleas (143 specimens) were collected from the bodies of 36 species (74 specimens) of British birds. There are single records of *Ceratophyllus styx* (2 specimens), *C. hirundinis* (10 specimens), *C. columbae* (1 specimen), *C. vagabunda* (2 specimens), *Nosopsyllus fasciatus* (1 specimen), and *Orchopeas wickhami* (1 specimen). There are 2 records of *C. rusticus* (26 specimens), 3 records of *C. garei* (4 specimens), 32 records of *C. gallinae* (52 specimens), and 36 records of *Dasyptysyllus g. gallinulae* (44 specimens).

The geographical distribution and host preferences of *C. vagabunda*, *C. garei*, *C. gallinae*, and *D. g. gallinulae* are discussed, and in addition the ratio of fleas found on the body and in the nest of the host and the sex-ratios of the three last-mentioned species are considered. It is shown that fleas may be collected from the bodies of birds at all times of the year, and not only in the breeding-season.

INTRODUCTION

THE fleas discussed in this paper were obtained by Miss Theresa Clay and Colonel Richard Meinertzhagen from the bodies of British birds and have recently been presented to the British Museum (Natural History). The collection numbers 143 specimens, more than double the total bird-fleas taken from the bodies of their hosts (as opposed to nests) in the combined Rothschild, Waterston, and British Museum cabinets. It thus forms the finest collection of its kind in existence, and in an effort to throw some light on various interesting points which it raises, especially concerning the host preferences and distribution of the three commonest bird-fleas, all the British records of these species have been reviewed and are discussed in the following pages.

It is still a general belief that fleas occur only occasionally on the bodies of adult avian hosts. As recently as 1949 O'Mahony writes: 'Two species of fleas have been collected, both from the bodies of the birds—a rare enough circumstance in itself.' It is, of course, true that bird-fleas are essentially nest-dwellers, but in small numbers they occur much more frequently on the host than is generally realized, and this becomes apparent if birds are sealed in containers impregnated with chloroform immediately they are shot and subsequently searched.

The material in the British Museum (N.H.), including the C. Rothschild and J. Waterston Collections, has been listed and the data arranged in Tables 2, 3, and 9 for comparison. Table 3 incorporates records generously supplied by various collectors (see acknowledgements) and additional information obtained from a thorough search of the literature prior to 1947.

Until recently authors have tended to record the common species of bird-fleas in

very general terms, which makes an accurate comparison of host-parasite relationships almost impossible. Thus, for example, Jeffrey (1922), who collected over a thousand fleas for Charles Rothschild, records *Ceratophyllus gallinae* 'in great abundance' from the nests of the Fowl (*Gallus domesticus*), Sparrow-Hawk (*Accipiter nisus*), Starling (*Sturnus vulgaris*), and Long-Eared Owl (*Asio otus*); 'in large numbers' from the Swift (*Apus apus*), and so forth. The actual number of positive nests is not supplied, and negative records are ignored altogether. Nor is it possible to arrive at the correct figures by examining the material in the Rothschild Collection itself, for many specimens have been given away and exchanged. Some records of material in the Rothschild Collection were passed on to other collectors for publication. Thus in 1936 I passed all my records of bird-fleas, including those in the C. Rothschild Collection, to G. B. Thompson, who published a quantity of them in his paper 'The Parasites of British Birds and Mammals' (1937c). Unfortunately, for some inexplicable reason, he omitted many of them and all the localities and dates. It should be noted that although he included the Honey Buzzard in his list, he did not enter any flea-species under this host! This may have been due to some query raised at the proof stage concerning this very interesting record. The whereabouts of the nest was kept secret by the late Mr. Meade Waldo, who discovered it in Cornwall. The present paper includes all the records of *Ceratophyllus gallinae*, *C. garei*, *C. vagabunda insularis*, and *Dasyptyllus g. gallinulae* which I had passed to G. B. Thompson already at that time. The records of *C. borealis* with full data have been republished by me (Rothschild, 1948). Several of the Scottish records (specimens collected by F. J. Cox and others) were published by Waterston (1914), and consequently care has to be exercised to avoid duplication, since the data on the slides are not always the same as the original data as published (see Table 9). Some slight differences will also be found between the Waterston material listed in Table 9 and in the original papers published by Waterston himself. These discrepancies can be explained by the following facts:

1. A number of specimens must have been given away by Waterston himself, during his lifetime, to other collectors.
2. Some specimens are present in the collection that have not been recorded in print.
3. A few of Waterston's determinations were incorrect. These are principally records of *Ceratophyllus fringillae*, which on re-examination of the specimens proved to refer to *C. gallinae*. Two of these misdeterminations were noted by Waterston himself (1909: 227).
4. Some mislabelling has occurred, particularly when the original labels became illegible through age. Thus in one instance, *Passer domesticus* has been rewritten on the outside of the tube as *Phasianus colchicus*!

In Table 3, column 2, some specimens given away in exchange between 1935 and 1950 are included, as well as material at present in the collection. In Table 9 the specimens actually in the British Museum (N.H.) in June 1950 are listed.

Except in the case of *C. vagabunda*, which is not a common species, records from the continental literature have not been taken into consideration. There are few

fleas more difficult to separate than the closely related bird-Ceratophylli, and consequently a large proportion of such records would require corroboration before they could be used. Moreover, the available records for the three common bird-fleas in Britain are quite extensive.

In this paper the host-nomenclature and the arrangement of the families of birds have been adapted from Witherby's *Handbook of British Birds*. Scientific names and authors' names are supplied in the tables, but sometimes omitted in the text, to avoid unnecessary repetition. In recent years many collectors name the subspecies of the bird host, but it has been thought better to adopt a binomial nomenclature in Tables 2, 3, and 9 because many of the subspecific names are open to suspicion. Thus, for example, several specimens of *C. gallinae* in the British Museum collection are recorded from nests of *Corvus monedula monedula* from Northampton and Norfolk in April and May; since this subspecies of the Jackdaw only occurs in Britain as a rare autumn migrant, it is safe to assume that an error has been made either in the identification of the host or in writing out the label. In the case of the collection made by Miss Clay and Colonel Meinertzhagen the identification of the host can be accepted without question, so in Table 1 the trinomials supplied by the collectors are listed in column 1.

Jo Bossanyi and the author made a search of the British literature prior to 1947, including many of the minor publications. After that date only the principal entomological journals have been consulted. There can be little doubt, therefore, that some records have been missed, but it is hoped that the list of authors and references will assist any future research concerned with British bird-fleas. Papers containing British records are starred.

ACKNOWLEDGEMENTS

The following collectors have kindly sent me lists of British bird-fleas from their own collections, many of which records have not hitherto been published, and I should like to thank them for their extremely generous help: H. Britten (45 records); R. B. Freeman (34 records); G. D. Morison (19 records); E. O'Mahony (57 records); G. B. Thompson (19 records); P. Tate (44 records from the Molteno Institute collection, most of which were determined by G. H. F. Nuttall or Charles Rothschild), and F. A. Turk (a number of negative records). I should also like to thank the following museums and institutions for information concerning bird-fleas: Marischal College, Aberdeen; Department of Zoology, University College of Wales, Aberystwyth; The Museum, Altrincham; The Museum, Belfast; The City Museum, Birmingham; The Museum, Blackburn; The Museum, Bradford; The City Museum, Bristol; Sexey's School Museum, Bruton; The Molteno Institute, Cambridge; The National Museum of Wales, Cardiff; The Museum, Carlisle; The Chelmsford and Essex Museum, Chelmsford; The Department of Zoology, University College, Cork; The Museum, Dunfermline; The Museum, Glasgow; The University, Glasgow; The Public Museum, Gloucester; The Belle Vue Museum, Halifax; The Educational Museum, Haslemere;

The Union Lodge Museum, Hawick; The Tolson Memorial Museum, Huddersfield; The Mortimer Museum, Hull; The Fitz Park Trust, Keswick; The Museum, Kettering; The Museum, Kilmarnock; The City Museums, Leeds; University College, Leicester; Littlehampton Museum, Littlehampton; The School of Hygiene Museum, University of Liverpool, Liverpool; The Museum, Mansfield; Marlborough College Natural History Society, Marlborough; The Hancock Museum, Newcastle-upon-Tyne; The Natural History Museum, Nottingham; The Museum, Peebles; The City of Perth Museum, Perth; The Harris Museum, Preston; The Department of Zoology, University of Reading, Reading; Denstone College Museum, Rochester; The Hertfordshire County Museum, St. Albans; The City Museum, Sheffield; The Essex Museum of Natural History, Stratford; The Museum, Sunderland; The County Museum, The Royal Institution of South Wales, Swansea; The County Museum, Truro; The City Museum, Wakefield; The Museum, Warrington; The Museum, Warwick; The Museum, Worthing.

I am also extremely grateful to Jo Bossanyi for searching through 142 of the lesser-known journals and periodicals dealing with British Natural History up to December 1946, and to G. H. E. Hopkins and F. G. A. M. Smit for criticizing the manuscript and supplying records from the literature and unpublished data. G. P. Holland has kindly sent me the new record of *C. vagabunda* from Canada, and with his usual helpfulness and enterprise K. Jordan has succeeded in obtaining several species of bird-fleas from Russia, in order that he could himself verify interesting records of I. Ioff. My remarks on distribution have been criticized by O. W. Richards, and I am most grateful to him for his kindness.

DESCRIPTION OF THE COLLECTION

The collection made by Miss Clay and Colonel Meinertzhagen is listed in Table 1. Ten species of fleas were found distributed among thirty-six species of birds, and of these four are host-specific, and are dealt with first.

TABLE 1

Fleas collected by Colonel Richard Meinertzhagen and Miss Theresa Clay from the Bodies of British Birds

	Host	Species of flea	Number and sex	Locality and date
CORVIDAE				
	<i>Corvus c. corax</i> L.	<i>Ceratophyllus gallinae</i> Schrank (1803)	1 ♀	Shetland, Aug. 1939
	Raven	<i>Dasypsyllus gallinulae gal- linulae</i> Dale (1878)	1 ♀	Shetland, Aug. 1939
	<i>Corvus f. frugilegus</i> L.	<i>C. gallinae</i>	1 ♀	Orkneys, Aug. 1938
	Rook (18 specimens shot)			
	<i>Corvus monedula spermologus</i> Vieill.	<i>C. gallinae</i>	1 ♀	Orkneys, Aug. 1938
	Jackdaw (36 specimens shot)	<i>Ceratophyllus vagabunda insularis</i> Roths. (1906)	2 ♂	Cornwall, Mar. 1946

TABLE I—(cont.)

Host	Species of flea	Number and sex	Locality and date
STURNIDAE			
<i>Sturnus vulgaris zelandicus</i> Hart. Shetland Starling (135 specimens shot)	<i>C. gallinae</i>	1 ♀	Shetland, Aug. 1938
	<i>C. gallinae</i>	1 ♂ 5 ♀	Shetland, Aug. 1939
	<i>Ceratophyllus garei</i> Roths. (1902)	1 ♀	Orkneys, Aug. 1938
	<i>C. gallinae</i>	2 ♂	North Uist, Aug. 1941
			2 ♀
FRINGILLIDAE			
<i>Fringilla coelebs gengleri</i> . . . Kleinschmidt British Chaffinch	<i>D. g. gallinulae</i>	2 ♂	Dartmoor, Apr. 1940
	<i>D. g. gallinulae</i>	1 ♂	Reading, May 1940
<i>Emberiza citrinella nebulosa</i> Gengler Yellow Hammer (56 specimens shot)	<i>C. gallinae</i>	1 ♀	County Kerry, Ireland, Oct. 1945
	<i>C. gallinae</i>	1 ♂	Cambridge, May 1941
	<i>C. garei</i>	1 ♀	Cornwall, May 1946
	<i>D. g. gallinulae</i>	1 ♀	Arran, Scotland, Oct. 1943
<i>Emberiza c. calandra</i> L. . . . Corn-Bunting	<i>D. g. gallinulae</i>	1 ♀	Cumberland, Apr. 1941
PLOCEIDAE			
<i>Passer d. domesticus</i> (L.) . . . House-Sparrow (35 specimens shot)	<i>C. gallinae</i>	1 ♀	Hampshire, Nov. 1944
	<i>C. gallinae</i>	1 ♂	Arran, Scotland, Oct. 1943
	<i>C. gallinae</i>	1 ♀	Shetland, Aug. 1939
ALAUDIDAE			
<i>Alauda a. arvensis</i> L. . . . Skylark	<i>C. garei</i>	1 ♂	Cumberland, Apr. 1941
		1 ♀	
<i>Alauda arvensis theresae</i> . . . Meinertzhagen	<i>D. g. gallinulae</i>	1 ♀	Co. Sligo, Ireland, Oct. 1950
MOTACILLIDAE			
<i>Anthus pratensis</i> (L.) Meadow Pipit	<i>D. g. gallinulae</i>	1 ♂	Dartmoor, Apr. 1940
		1 ♀	
<i>Anthus spinoletta meinertzhageni</i> . Bird. Hebridean Rock-Pipit	<i>D. g. gallinulae</i>	1 ♂	Sutherlandshire, Apr. 1944
CERTHIIDAE			
<i>Certhia familiaris britannicus</i> . Ridgw. British Tree-Creeper	<i>C. gallinae</i>	1 ♂	Wales, Jan. 1942
PARIDAE			
<i>Parus major newtoni</i> Prazak . . British Great Tit (66 specimens shot)	<i>C. gallinae</i>	1 ♂	Cumberland, Apr. 1941
		1 ♀	
	<i>C. gallinae</i>	1 ♂	Cumberland, Apr. 1941
		2 ♀	
	<i>D. g. gallinulae</i>	1 ♀	Cumberland, Apr. 1941

TABLE I—(cont.)

Host	Species of flea	Number and sex	Locality and date
<i>Parus major newtoni</i> (cont.)	<i>D. g. gallinulae</i>	1 ♀	Buckinghamshire, July 1941
	<i>D. g. gallinulae</i>	1 ♀	Reading, June 1941
	<i>D. g. gallinulae</i>	1 ♂	Hampshire, Apr. 1941
	<i>D. g. gallinulae</i>	1 ♂	Cumberland, Apr. 1941
	<i>Orchopeas wickhami</i> Baker (1895)	1 ♂	Berkshire, Mar. 1946
<i>Parus coeruleus obscurus</i> Prazak British Blue-Tit	<i>C. gallinae</i>	4 ♀	Cumberland, Apr. 1941
MUSCICAPIDAE			
<i>Muscicapa s. striata</i> (Pall.) Spotted Flycatcher	<i>C. gallinae</i>	1 ♀	Hampshire, June 1941
SYLVIIDAE			
<i>Acrocephalus schoenobaenus</i> (L.) Sedge-Warbler	<i>D. g. gallinulae</i>	1 ♀	Hampshire, June 1941
<i>Sylvia n. nisoria</i> (Bechstein) Barred Warbler	<i>C. gallinae</i>	1 ♀	Shetland, Aug. 1939
<i>Sylvia b. borin</i> (Bodd.) Garden-Warbler	<i>C. gallinae</i>	1 ♂	Shetland, Aug. 1939
<i>Sylvia a. atricapilla</i> (L.) Blackcap	<i>D. g. gallinulae</i>	1 ♀	Winchester, June 1941
<i>Sylvia c. cinerea</i> Bechstein Whitethroat	<i>D. g. gallinulae</i>	2 ♀	Reading, May 1940
TURDIDAE			
<i>Turdus philomelos hebridensis</i> Clarke. Hebridean Song-Thrush	<i>C. gallinae</i>	1 ♀	North Uist, Aug. 1941
<i>Turdus m. merula</i> L. Blackbird	<i>D. g. gallinulae</i>	1 ♂	Co. Kerry, Ireland, Oct. 1945
	<i>D. g. gallinulae</i>	1 ♂	Arran, Scotland, Oct. 1943
<i>Oenanthe o. oenanthe</i> (L.) Wheatear	<i>D. g. gallinulae</i>	1 ♀	Orkneys, Aug. 1938
<i>Saxicola torquatus theresae</i> Meinertz. Hebridean Stonechat	<i>D. g. gallinulae</i>	1 ♂	Scilly Isles, Mar. 1943
	<i>D. g. gallinulae</i>	1 ♀	Hampshire, Apr. 1941
<i>Erithacus rubecula melophilus</i> Hart. British Robin	<i>C. gallinae</i>	1 ♂	Hampshire, Apr. 1941
	<i>C. gallinae</i>	1 ♂	Arran, Scotland, Oct. 1943
	<i>D. g. gallinulae</i>	1 ♂	Arran, Scotland, Oct. 1943
	<i>D. g. gallinulae</i>	1 ♂	Arran, Scotland, Oct. 1943
	<i>D. g. gallinulae</i>	1 ♂	Arran, Scotland, Oct. 1943
	<i>D. g. gallinulae</i>	2 ♀	Cumberland, Apr. 1941
	<i>D. g. gallinulae</i>	1 ♂	Hampshire, Apr. 1941
<i>D. g. gallinulae</i>	1 ♂	Co. Kerry, Ireland, Oct. 1945	

TABLE I—(cont.)

Host	Species of flea	Number and sex	Locality and date
PRUNELLIDAE			
<i>Prunella modularis occidentalis</i> (Hart.) British Hedge-Sparrow (90 specimens shot)	<i>C. gallinae</i>	1 ♀	Scilly Isles, Mar. 1945
	<i>C. gallinae</i>	1 ♀	Co. Galway, Ireland, Jan. 1947
	<i>C. gallinae</i>	1 ♂	Winchester, June 1941
	<i>D. g. gallinulae</i>	1 ♂	Winchester, June 1941
	<i>D. g. gallinulae</i>	1 ♀	Cumberland, Apr. 1941
	<i>D. g. gallinulae</i>	1 ♂	Cumberland, Apr. 1941
	<i>D. g. gallinulae</i>	2 ♀	Apr. 1941
	<i>D. g. gallinulae</i>	1 ♂	Co. Galway, Ireland, Jan. 1947
<i>Prunella modularis hebridium</i> Meinertz. Hebridean Hedge-Sparrow	<i>C. gallinae</i>	1 ♀	Harris, Outer Hebrides, Nov. 1949
	<i>C. gallinae</i>	1 ♂	N. Uist, Outer Hebrides, Nov. 1949
	<i>D. g. gallinulae</i>	1 ♂	N. Uist, Outer Hebrides, Nov. 1949
TROGLODYTIDAE			
<i>Troglodytes t. troglodytes</i> (L.) Wren	<i>D. g. gallinulae</i>	1 ♂	Sutherlandshire, Oct. 1944
	<i>D. g. gallinulae</i>	1 ♀	Co. Kerry, Ireland, Oct. 1945
	<i>D. g. gallinulae</i>	1 ♂	Hampshire, June 1941
	<i>Nosopsyllus fasciatus</i> Bosc. (1800)	1 ♀	Arran, Scotland, Oct. 1943
<i>Troglodytes t. hebridensis</i> Meinertz. Hebridean Wren	<i>D. g. gallinulae</i>	1 ♂	Rodel, Harris, Outer Hebrides, Nov. 1949
HIRUNDINIDAE			
<i>Delichon u. urbica</i> (L.) House-Martin (7 specimens shot)	<i>Ceratophyllus rusticus</i> Wagner (1903)	13 ♂ 12 ♀	Wiltshire, Aug. 1946
	<i>C. rusticus</i>	1 ♀	Wiltshire, Aug. 1946
	<i>Ceratophyllus hirundinis</i> Curtis (1826)	5 ♂ 5 ♀	Wiltshire, Aug. 1946
<i>Riparia r. riparia</i> (L.) Sand-Martin (2 specimens shot)	<i>Ceratophyllus styx</i> Roths. (1900)	2 ♂	Inverness, Aug. 1941
PICIDAE			
<i>Dryobates major anglicus</i> (Hart.) British Great Spotted Wood- pecker	<i>C. gallinae</i>	1 ♂	Berkshire, Mar. 1946
STRIGIDAE			
<i>Athene noctua vidalii</i> Brehm. Little Owl	<i>C. gallinae</i>	3 ♂ 3 ♀	Hampshire, June 1941
FALCONIDAE			
<i>Accipiter n. nisus</i> (L.) Sparrow-Hawk	<i>C. gallinae</i>	1 ♂	Suffolk, date unknown

TABLE I—(cont.)

	Host	Species of flea	Number and sex	Locality and date
HYDROBATIDAE				
	<i>Fulmarus g. glacialis</i> (L.) Fulmar Petrel	<i>D. g. gallinulae</i>	1 ♀	Orkneys, Aug. 1938
COLUMBIDAE				
	<i>Columba l. livia</i> Gm. Rock-Dove	<i>C. gallinae</i>	2 ♀	Shetland, Aug. 1939
		<i>C. gallinae</i>	1 ♀	North Uist, Aug. 1941
		<i>Ceratophyllus columbae</i> Walck. & Gerv. (1844)	1 ♂	Ross of Mull, Feb. 1944
RALLIDAE				
	<i>Gallinula c. chloropus</i> (L.) Moorhen	<i>D. g. gallinulae</i>	1 ♀	Orkneys, Aug. 1938
TETRAONIDAE				
	<i>Lagopus s. scoticus</i> (Lath.) British Red Grouse	<i>C. gallinae</i>	1 ♀	Orkneys, Aug. 1938

A. HOST-SPECIFIC SPECIES

1. *Ceratophyllus styx* Rothschild, 1900. This strictly host-specific flea swarms in the burrows of the Sand-Martin (*Riparia r. riparia*), and according to Evans (1904) and Waterston (1916), both sexes overwinter in the nest as pupae or imagines. Jolley and Storer (1945) record that 20 per cent. of nestling Sand-Martins were found to be infested, but the two males collected by Colonel Meinertzhagen (Table 1) appear to be the first recorded from the adult bird. Owing to the large numbers of *C. styx* present in individual nests, and the fact that it is sometimes found 'free' in sand quarries far removed from a nest, it is surprising that it is not collected more often as a straggler on other hosts. There are four records from nests of the Dipper (*Cinclus cinclus*) in Britain (Rothschild, 1915; Britten, 1920; and Walsh, 1938), and Mr. Edward Armstrong informs me that this bird's habits might well bring it into contact with this flea, since it has been known to roost in disused Sand-Martin burrows. Mr. H. Britten has kindly sent me a record of *C. styx* from the nest of the Redstart (*Phoenicurus phoenicurus*) collected by F. Taylor at New Mill, Cheshire, 1921, but unfortunately neither he nor I have had the opportunity of examining this particular specimen.

Further collecting from the nests of the Sand-Martin, especially in northern Scotland, is most desirable. Up to the time of writing *C. styx* is the only species recorded from this host in Britain. Recently Miss Clay has collected several specimens of *C. riparius* Jordan & Rothschild, 1920, and *Frontopsylla lapponica* Nordberg, 1934, from the nest of the Sand-Martin in north-east Sweden. The former species has hitherto been known as the host-specific flea of the Sand-Martin (*Riparia r. riparia*) in North America (including Canada), and there are also records from Trans-Baikal (several specimens in the C. Rothschild collection received from I. Ioff and the determinations checked by K. Jordan). It is also possible that *C. riparius* will be discovered in burrows of the Sand-Martin in northern Scotland, since the ranges of

this species and of *C. styx* probably overlap at some point in north Europe. *F. lapponica* may also occur in Scotland; the only other record is from Finland.

2 and 3. *Ceratophyllus hirundinis* Curtis, 1826, and *Ceratophyllus rusticus* Wagner, 1903. It is a well-known fact that the nests of the House-Martin (*Delichon u. urbica*) are richer in fleas, both as regards species and actual numbers, than those of any other bird in Britain (Waterston, 1910; M. Rothschild, 1947; and Allan, 1950). It is therefore not surprising to find that the highest number of fleas collected off an individual host came from the House-Martin: Colonel Meinertzhagen found twenty-five specimens of *C. rusticus* on one bird and ten of *C. hirundinis* on another.

It is a point of considerable interest that *C. hirundinis* is confined to the House-Martin in Great Britain, although it is apparently found in nests of the Swallow (*Hirundo rustica*) on the continent of Europe (Wagner, 1930). In the British Museum collection there are three specimens of *C. hirundinis* and one of *C. rusticus* obtained in different parts of Germany in nests of the Swallow, apart from the numerous records from the continental literature which include an exceptionally heavy infestation of *C. hirundinis*—2,000 specimens—from one nest. It seems unlikely that all the existing records from this host can be attributed to careless collecting or misidentification of the host. The same may be said of *C. rusticus*, which has only once been recorded from the Swallow in Britain (Rothschild, 1947), and until recent years was considered a rare flea in this country.

The distribution of House-Martin fleas in general presents certain baffling problems. Judging from their flea fauna, it seems possible that relatively small communities of these birds must remain isolated over long periods of time, and the distribution of *C. hirundinis* and *C. rusticus* suggests the same may apply in a lesser degree to the Swallow. In the east of Scotland *Orneacus waterstoni* (Jordan) 1925 and *Frontopsylla laetus* (Jordan & Rothschild) 1920 have been recorded from the nests of the House-Martin. These fleas appear to be absent from England and Eire and over the larger part of Europe, but occur in the Swiss Alps. A related species of *Orneacus* is recorded from the Himalayas. The presence of *Orneacus* and *Frontopsylla* in these nests and their absence elsewhere may be due to climatic changes in the past, and could also be governed by some temperature or humidity requirements of the larvae, but it nevertheless seems unlikely that this factor alone accounts for the distribution of these fleas and prevents a secondary spread southwards on the House-Martin. It is obvious in the case of *C. hirundinis*, which in Britain pullulates in the nests of the House-Martin breeding in the same district as the Swallow, that this cannot be the only explanation why it is not found in nests of the latter species.

It is also worth noting that the exchange of fleas between Sparrows and House-Martins appears to be entirely one-sided in Britain. *Ceratophyllus gallinae* (Schrank) 1803 and *Ceratophyllus fringillae* (Walker) 1856 are found from time to time in the nest of the latter (Evans, 1906; Waterston, 1906; Bagnall, 1921; and Rothschild, 1947), but no House-Martin fleas seem to survive on Sparrows. There is, however, one specimen of *C. hirundinis* from a House-Sparrow in Germany in the C. Rothschild collection.

4. *Ceratophyllus columbae* (Walckenaer & Gervais) 1844. The Domestic Pigeon and the Rock-Dove (*Columba l. livia*) are infested, in Europe, with a host-specific flea,

C. columbae, which is absent, however, from the dove-cots of the U.S.A. (Jordan, 1923; Rothschild, 1952 in press). The collection contains one male of this species from a Rock-Dove shot in Ross of Mull. On two occasions *C. gallinae* was taken from the Rock-Dove, and it is this species which infests the domestic pigeon in the Eastern United States. It should be noted that *C. columbae* is not a parasite of the Wood-Pigeon (*Columba palumbus* L.) as stated by G. B. Thompson (1937). There are no records from this bird, except Thompson's own record from a London Wood-Pigeon, which had presumably come into close contact with domestic pigeons.

B. SPECIES WHICH ARE NOT HOST-SPECIFIC, BUT SHOW SOME HOST-PREFERENCE

Ceratophyllus vagabunda insularis Rothschild, 1906. Two male specimens of *C. vagabunda insularis* were obtained from a Jackdaw (*Corvus monedula spermologus* Vieillot) shot in Cornwall (see also O'Mahony, 1948: 89). This flea has an interesting distribution, and also displays a somewhat peculiar choice of hosts, favouring three widely separated groups of birds, the Corvidae, Laridae, and Order Falconiformes. Since *C. vagabunda* has broken up into subspecies (Jordan, 1926) of which *C. v. insularis* is peculiar to the British Isles, we may deduce that it is a relatively ancient form. The species as a whole displays an alpine-boreal distribution, occurring in Alaska, Canada, Spitzbergen, Great Britain, Sweden, Finland, Turkestan, Siberia, and the Swiss Alps (Jordan, 1932). Recently there has been a record from Belgium (Cooreman, 1947), but F. G. A. M. Smit and F. Peus (personal communications) have failed to find it in nests in Holland and Germany, although between them they have examined over one hundred Gulls' nests and also Jackdaws' nests. This type of distribution is reminiscent of that of *C. borealis*, only *C. vagabunda* is not markedly restricted to islands (Rothschild, 1948).

A glance at Table 2, listing the specimens in the British Museum and other British records together with their hosts, shows that a wide variety of birds may be infested. In the 'Synopsis of the British Siphonaptera' (Rothschild, 1915) this flea is described as 'a rare species frequenting the nests of sea birds', and the statement is widely quoted in the literature. There are, however, five other records from the Jackdaw in Britain (O'Mahony, 1948, and Table 2), and it will be noted that those listed in Table 2 were taken far inland in Northamptonshire, Midlothian, and Herefordshire. The male from which the British subspecies of the flea was originally described (Rothschild, 1906) was obtained from a hollow tree in Reading, Berkshire, which had been used successively by Woodpecker, Owl, and Starling. It is more than likely that this hole had also been occupied by Jackdaws at one time or another. The same may be said of the hollow tree at Hampton Court, Middlesex, in which a specimen of *C. vagabunda* was found inside a *Crataegus* seed in the store of *Mus* sp. (Waterston, 1923). There is also a record of this species from the Jackdaw in Sweden (Wahlgren, 1903 and 1907) and Belgium (Cooreman, 1947), one from the Magpie (*Pica pica*) at Ashton, Peterborough, one from the Raven (*Corvus corax*) on Inishtrahull (O'Mahony, 1941), and the host of *C. v. alpestris* in the Swiss Alps is also a Corvid, the Mountain Chough (*Pyrrhocorax graculus*). In Finland Nordberg records it from no less than 100 per cent. of the Jackdaws' nests which he examined—fifty-seven in all—and Cooreman concluded from this that the Jackdaw was probably

TABLE 2
Records of C. vagabunda Boheman (1866)

Name of host (all from nests unless otherwise stated)	Localities	Total No. of records for each host	Location of specimens	First published record
CORVIDAE				
<i>Corvus corax</i> L. Raven	Inishtrahull Isles, Co. Donegal (Eire)	1	Nat. Mus. Dublin	O'Mahony, 1941
<i>Corvus monedula</i> L. Jackdaw	Cornwall (England)	1	R. Meinertzhagen Coll. (det. M. Rothschild)	O'Mahony, 1948
	Treago Park, Hereford (England)	2*	E. O'Mahony Coll.	O'Mahony, 1948 and present paper
	Colinton, Midlothian (Scotland)	3†	B.M. (J. Waterston Coll.)	Waterston, 1906 (as <i>C. insularis</i> Roths.)
	Ashton, Peterborough (England)	3	69 B.M. (C. Rothschild Coll.)	Present paper, ‡ and O'Mahony, 1948
(Recorded as <i>Coloesus monedula</i>)	Sweden	1	Probably Wahlgren Coll.	Wahlgren, 1907 (as <i>C. monedulae</i>)
(Recorded as <i>Coloesus monedula</i>)	Towns and villages in Finland	57	Unknown	Nordberg, 1934
(Recorded as <i>Coloesus monedula</i>)	Godinne (Belgium)	2§		Cooreman, 1947
<i>Pica pica</i> (L.) Magpie (labelled <i>Pica rusticus</i>)	Ashton, Peterborough (England)	1	B.M. (C.R. Coll.)	Present paper
<i>Pyrhocorax graculus</i> L. Mountain Chough	Above Findelen, Zer- matt (Switzerland)	1	B.M. (C.R. Coll.) (Type of Alpine sub- species <i>C. vaga- bunda alpestris</i> J. 1926)	Jordan & Rothschild, 1920
STRIGIDAE				
<i>Bubo bubo</i> (L.) Eagle-Owl	Jomala (Finland)	1	Unknown	Nordberg, 1934
<i>Strix aluco</i> L. Tawny Owl	Arniston, Midlothian (Scotland)	1	B.M. (J.W. Coll.)	Present paper
FALCONIDAE				
<i>Falco peregrinus</i> Tunst. Peregrine Falcon	Tintagel, Cornwall (England)	1	B.M. (C.R. Coll.)	Present paper
	Finland	1	Unknown	Nordberg, 1936
ACCIPITRIDAE				
<i>Aquila chrysaetus</i> (L.) Golden Eagle (From nest and nest- lings)	Rapids, Alaska	1	Rocky Mountain Lab., Hamilton, Montana (det. Karl Jordan; seen by M. Rothschild)	Phillip, 1938

* One of these records has not been published by E. O'Mahony.

† In Waterston's (1906) paper three separate collections are given with dates and the comment 'common in the nest of *Corvus monedula*'. The specimens in the British Museum are dated 7.5.06 and 24.5.06, and those of 19.6.06 are missing.

‡ There is no way of ascertaining whether Thompson (1937) included this record or not in his list, since he does not indicate the source of his data. This also applies to several of the other specimens which are entered in this column as 'first published record in the present paper'.

§ The record reads 'found in numbers in the nests of *Coloesus monedula*', but we have only counted it as two records.

|| Unless otherwise stated only the specimens in the British Museum collection have been seen by the author.

TABLE 2—(cont.)

Name of host (all from nests unless otherwise stated)	Localities	Total No. of records for each host	Location of specimens	First published record
<i>Buteo buteo</i> (L.) Common Buzzard	Finstrom, Finland	1	Unknown	Nordberg, 1934
<i>Accipiter nisus</i> (L.) Sparrow-Hawk	Jomala, Finland	1	Unknown	Nordberg, 1934
<i>Pernis apivorus</i> (L.) Honey-Buzzard	Cornwall (England)	1	B.M. (C.R. Coll.)	Present paper
ANATIDAE				
<i>Anser brachyrhynchus</i> Baillon	Advent Bay, Spitz- bergen	1	B.M. (C.R. Coll.)	Jordan, 1932
Pink-footed Goose (Recorded as <i>Melan- onyx brachyrhynchus</i>)	Spitzbergen	1		
<i>Branta leucopsis</i> (Bechst.) Barnacle-Goose	Advent Bay, Spitz- bergen	1	B.M. (C.R. Coll.)	Jordan, 1932
PHALACROCORACIDAE				
<i>Phalacrocorax carbo</i> (L.) Cormorant (Recorded as Cor- morant)	Farne Islands, Northumberland (England)	1	R. S. Bagnall Coll.	Bagnall, 1921
<i>Phalacrocorax aristotelis</i> (L.) Shag (From nest and nest- lings)	Bodd and Stoil, Canna Isle (Scotland)	1	Glasgow Univ. Coll. (det. K. Jordan)	Carrick, 1939
	Lambay Island (Eire)	1		
PROCELLARIIDAE				
<i>Fulmarus glacialis</i> (L.) Fulmar Petrel	St. Kilda (Scotland)	1	B.M. (J.W. Coll.)	Waterston, 1906 (as <i>C. insularis</i>)
COLUMBIDAE				
<i>Columba livia</i> Gm. Rock-Dove	Cave in cliff, Todhead, Kinneff (Scotland)	1	B.M. (J.W. Coll.)	Present paper
LARIDAE				
<i>Larus argentatus</i> Pont. Herring-Gull	Burwick, Orkney Isles (Scotland)	1	B.M. (J.W. Coll.)	Waterston, 1906 (as <i>C. insularis</i>)
	Cliffs near Todhead, Kinneff (Scotland)	2		
	Ireland's Eye, Co. Dub- lin (Eire)	6**	E. O'M. Coll.	O'Mahony, 1941, and present paper
	Casana Rock, Howth, Co. Dublin (Eire)	1	E.O'M. Coll.	O'Mahony, 1939
	Lambay Isle (Eire)	2**	E.O'M. Coll.	O'Mahony, 1939, and present paper
	Cruden Bay (Scotland)	6		Allan, 1950
	Portlethen, Kincar- dineshire (Scotland)	3		Allan, 1950
	Muchalls, Kincardine- shire (Scotland)††	2		

** Five of these records and one of those from Lambay Isle are published here for the first time.

†† The record says 'nests', but as no numbers are given this is treated as two records.

TABLE 2—(cont.)

Name of host (all from nests unless otherwise stated)	Localities	Total No. of records for each host	Location of specimens	First published record
<i>Larus hyperboreus</i> Gunn. The Glaucous Gull (Recorded by Wagner as <i>Larus glaucus</i>)	North Siberia	1	Unknown. (Type of subspecies <i>C. vagabunda orientalis</i> †† Wagner, 1929)	Wagner, 1929
	Kidliut Bay, North- West Territory (Canada)	1		B.M. and G. P. Hol- land Coll. (det. G. P. Holland and K. Jordan)
<i>Rissa tridactyla</i> (L.) Kittiwake	Isle of May (Scotland)	2	B.M. (C.R. Coll.)	Rothschild, 1915
	Great Skellig, Co. Kerry (Eire)	1		
<i>Pagophila eburnea</i> (Phipps) Ivory Gull (From nestling in nest)	Spitzbergen	1	B.M. (C.R. Coll.)	Present paper
ALCIDAE				
<i>Fratercula arctica</i> (L.) Puffin	Sheep Island, off Bal- lintoy (Eire)	1	G. B. Thompson Coll.	Thompson, 1937
	St. Kilda (Scotland)	1		
DOMESTIC POULTRY				
<i>Gallus domesticus</i> L. Domestic Fowl (From nest ?)	Djarkent, Turkestan	1	B.M. (C.R. Coll.)	Waterston, 1923, and present paper
	Narankol, Turkestan	1		
MAMMALIAN HOST				
<i>Apodemus tscherga</i> (= <i>Apodemus s. tscherga</i> Kasts.)	Djarkent, Turkestan	1	B.M. (C.R. Coll.)	Waterston, 1923
UNCLASSIFIED HOSTS				
A hole in a tree occupied successively by Star- ling, Woodpecker, and Owl	Near Reading, Berk- shire (England)	1	B.M. (C.R. Coll.). (Type specimen of British subspecies <i>C. vagabunda insu- laris</i> Rothschild, 1906)	Rothschild, 1906
Inside seed of <i>Crataegus</i> in store of <i>Mus</i> sp. in hollow tree	Hampton Court, Middlesex (England)	1	B.M. (J.W. Coll.)	Waterston, 1923
Nests of sea-birds	Shetland Isles (Scot- land)	Several	B.M. (J.W. Coll.)	Waterston, 1914
Coming down the rocks	St. Kilda Isle (Scot- land)	1	B.M. (J.W. Coll.)	Waterston, 1906 (as <i>C. insularis</i>)
On the ground? (no data)	Farne Islands, North- umberland (England)	1	B.M. (C.R. Coll.)	Present paper
Off clothing	Klass Billen Bay, Spitz- bergen	1	B.M. (C.R. Coll.)	Present paper

†† The author has not seen this specimen, but judging from the description its status as a subspecies appears doubtful.

TABLE 2—(cont.)

Name of host (all from nests unless otherwise stated)	Localities	Total No. of records for each host	Location of specimens	First published record
Jumping about on the ground	Kap Todsen, Isfjorden, Spitzbergen	4	Reichsmus., Stock- holm. (Type of arctic subspecies <i>C. vagabunda vaga- bunda</i> Boheman, 1866; seen by M. Rothschild)	Boheman, 1866 (as <i>C. digitalis</i> Wahl- gren, 1903)
Herbage (about 50 ft. below gull's nest)	Muchalls, Kincardine (Scotland)	1	G. D. Morison Coll.	Present paper

the 'normal host for this flea'. Nordberg also found it in one nest each of the Eagle Owl (*Bubo bubo*), the Buzzard (*Buteo buteo*), the Peregrine Falcon (*Falco peregrinus*), and the Sparrow-Hawk (*Accipiter nisus*).

The tendency to favour birds of prey (Falconidae and Accipitridae) may be observed in Great Britain, where *C. vagabunda* has been collected from the nests of the Peregrine Falcon and the Honey-Buzzard (*Pernis apivorus*). In Alaska it was taken from a nest of the Golden Eagle (*Aquila chrysaëtus*). An equally favoured group of birds appears to be the Gulls. There are twenty-two records from the Herring-Gull (*Larus argentatus*) in Britain, two from the Kittiwake (*Rissa tridactyla*), one from the Ivory-Gull (*Pagophila eburnea*) in Spitzbergen, and the Glaucous Gull (*Larus hyperboreus*) in Siberia, and in Canada (see Table 2).

Characteristics common to these hosts are difficult to find. A large proportion of them build on precipitous rocks or cliffs, and the Corvidae, certain birds of prey, and various Gulls, as well as the Shag and Cormorant (Table 2), construct large, bulky nests. It is obvious, however, from a glance at the list of hosts that neither of these requirements is essential to *C. vagabunda*.

It is often assumed that species which display a so-called fringing or relict distribution, like *C. vagabunda*, were once distributed widely over the Continent, but were restricted to their present limited area during or following one of the ice ages. With this possibility in mind it is tempting to speculate on the identity of the true host of *C. vagabunda* in the past. The Choughs (*Pyrrhocorax*) instantly spring to mind. These birds, which build bulky nests on rocky and precipitous cliffs, were undoubtedly more widely distributed in the past. Moreover, the Mountain Chough is the host of *C. v. alpestris* in the Alps, and the fairly closely related Jackdaw is the favoured host inland in Europe today.

It would be a relatively easy task, and an interesting one, to trace the distribution of *C. vagabunda* on the Jackdaw in Europe. It seems possible that at the present time there is a secondary spread of this flea southwards again on this particular host. Another point of interest is whether the north European subspecies, *C. v. vagabunda*, is present on migrating Jackdaws which visit this country. There is every reason to suppose that it is, and during the winter months both subspecies are probably to be found in Great Britain.

It is perhaps worth noting that a relatively high proportion of records of *C. vagabunda* are of 'free' specimens, that is to say specimens collected away from any particular host: 'Jumping about on the ground'; 'Off clothing'; 'Coming down the rocks'; 'Inside a *Crataegus* seed', and so forth (Boheman, 1866; Waterston, 1923, and Table 2). The impression is created that certain areas such as sea cliffs in particular districts, for example the east coast of Ireland (O'Mahony, 1949) or the Tintagel district in Cornwall, are infested with these fleas, which possibly migrate from the nests if the temperature falls, or when they become hungry (Waterston, 1910; Nordberg, 1936; and Ioff, 1946), and in due course wander on to other species of birds nesting in the vicinity which will also serve as hosts.

If indeed *C. vagabunda* is a 'relict' species, reduced to a mere fringe of its former distribution either by climatic changes or by the gradual elimination of its principal host, it may owe its survival to the crowded breeding conditions on rocky cliffs along the coast, and to its ability to spread without being actually carried on the body of the host to its nest.

C. SPECIES WHICH ARE NOT HOST-SPECIFIC AND SHOW LITTLE OR NO HOST-PREFERENCE

1. *Ceratophyllus garei* Rothschild, 1902. In this collection there are only three records of *C. garei* (Table 1), compared with thirty-three of *C. gallinae* and thirty-five of *Dasypsyllus gallinulae gallinulae* (Dale) 1878. The ratio of *C. garei* to the other two common bird-fleas in this collection is therefore unusually low, approximately 1:22 instead of the expected 1:6, as shown in the overall records in Table 4. There are two probable explanations to account for this fact. Out of the thirty-six species of birds shot by Colonel Meinertzhagen, twenty-nine are of the Order Passeriformes. It will be seen from Table 4 that out of a total of 108 records of *C. garei* only 35 per cent. are from Passerine birds, whereas 86 per cent. of records of *C. gallinae* and no less than 92 per cent. of records of *D. g. gallinulae* are from this order. The second reason for the relatively small number of *C. garei* is the fact that this species is apparently less frequently found on the bodies of its hosts than either of the two other common British bird-fleas (Table 4).

The host-preferences of *C. garei* appear to be governed more by the situation of the nest than by any other factor. Nevertheless there are certain features concerning its choice of host which are difficult to explain on the basis of the nesting site or microclimate alone. It must not be forgotten that we only guess at the reason why damp sites are chosen. Since Buxton's excellent work on the biology of *Xenopsylla cheopis* (Buxton, 1938) the most favoured explanation centres round the humidity requirements of the larvae, but no actual experiments have been carried out with *C. garei*. Moreover, very little indeed is known about the actual conditions in the nests of different species of birds, and there are no reliable data available by which we could compare the microclimate of a Linnet's or a Robin's nest.

It will be seen from Table 3 that *C. garei* is the only species of flea which has been recorded from the Anatidae (sixteen records in Britain). There are also thirteen records of this species from the Scolopacidae, from which family there are no records of *C. gallinae* and only two of *D. g. gallinulae*. *C. garei* is also the dominant species

TABLE 3

British Bird Hosts of C. gallinae, C. garei, and D. g. gallinulae
(from the British Museum collections, the literature, and unpublished sources)

Host	Source of record	C. gallinae	C. garei	D. g. gallinulae	Host	Source of record	C. gallinae	C. garei	D. g. gallinulae
<i>Corvus corax</i> L.	Ors.*	2	—	1	<i>Anthus spinoletta</i> (L.)	{ B.M.	1	—	1
Raven					Rock-Pipit	{ Ors.	—	—	1
<i>Corvus corone</i> L.	{ B.M.	6	1	—	<i>Motacilla alba yarrelli</i>				
Carrion-Crow	{ Ors.	1	—	1	Gould	B.M.	3	2	5
<i>Corvus frugilegus</i> L.	{ Ors.	1	—	—	Pied Wagtail				
Rook					<i>Motacilla cinerea cinerea</i>	{ B.M.	—	—	2
<i>Corvus monedula</i> L.	{ B.M.	9	—	2	Tunst.	{ Ors.	—	—	1
Jackdaw	{ Ors.	3	—	1	Grey Wagtail				
<i>Pica pica</i> (L.)	B.M.	2	—	—	<i>Certhia familiaris</i> (L.)	{ B.M.	—	—	1
Magpie					Tree-Creeper	{ Ors.	1	—	2
<i>Garrulus glandarius</i> (L.)	Ors.	—	—	1	<i>Sitta europaea</i> L.	B.M.	1	—	—
Jay					Nuthatch				
<i>Sturnus vulgaris</i> L.	{ B.M.	29	1	4	<i>Parus major</i> L.	{ B.M.	15	—	4
Starling	{ Ors.	13	1	2	Great Tit	{ Ors.	10	—	5
<i>Coccothraustes cocco-</i>					<i>Parus coeruleus</i> L.	{ B.M.	13	—	2
<i>thraustes</i> (L.)	Ors.	—	—	1	Blue Tit	{ Ors.	23	—	2
Hawfinch					<i>Parus ater</i> L.	Ors.	—	—	1
<i>Chloris chloris</i> (L.)	{ B.M.	1	—	6	Coal-Tit				
Greenfinch	{ Ors.	1	—	3	<i>Parus atricapillus</i> L.	Ors.	1	—	1
<i>Carduelis carduelis</i> (L.)	B.M.	1	1	—	Willow-Tit				
Goldfinch					<i>Aegithalos caudatus</i> (L.)	{ B.M.	—	—	1
<i>Carduelis spinus</i> (L.)	Ors.	1	—	—	Long-tailed Tit	{ Ors.	1	—	2
Siskin					<i>Panurus biarmicus</i> (L.)	B.M.	—	2	—
<i>Carduelis cannabina</i> (L.)	{ B.M.	—	2	—	Bearded Tit				
Linnet	{ Ors.	—	1	—	<i>Lanius collurio</i> L.	Ors.	—	—	1
<i>Fringilla coelebs</i> L.	{ B.M.	3	—	6	Red-backed Shrike				
Chaffinch	{ Ors.	2	1	4	<i>Muscicapa striata</i> (Pall.)	{ B.M.	3	—	5
<i>Pyrrhula pyrrhula</i> (L.)	{ Ors.	—	—	1	Spotted Flycatcher	{ Ors.	1	—	—
Bullfinch					<i>Muscicapa hypoleuca</i> (Pall.)	Ors.	1	—	2
<i>Emberiza citrinella</i> L.	{ B.M.	2	1	1	Pied Flycatcher				
Yellow Bunting	{ Ors.	2	1	7	<i>Regulus regulus</i> (L.)	Ors.	1	—	1
<i>Emberiza calandra</i> L.	{ B.M.	—	1	—	Goldcrest				
Corn-Bunting	{ Ors.	—	—	1	<i>Phylloscopus collybita</i>	B.M.	1	—	2
<i>Emberiza schoeniclus</i> (L.)	{ B.M.	—	2	1	(Viell.)				
Reed-Bunting	{ Ors.	1	—	—	Chiff-chaff				
<i>Passer domesticus</i> (L.)	{ B.M.	29	1†	3	<i>Phylloscopus trochilus</i> (L.)	{ B.M.	—	—	3
House-Sparrow	{ Ors.	17	—	—	Willow-Warbler	{ Ors.	—	—	5
<i>Passer montanus</i> (L.)	{ Ors.	3	—	1	<i>Phylloscopus sibilatrix</i>	{ B.M.	—	—	1
Tree-Sparrow					(Bechst.)	{ Ors.	1	—	—
<i>Alauda arvensis</i> L.	{ B.M.	2	1	5	Wood-Warbler				
Skylark	{ Ors.	—	4	—	<i>Locustella naevia</i> (Bodd.)	Ors.	1	2	1
<i>Anthus trivialis</i> (L.)	{ Ors.	—	—	1	Grasshopper-Warbler				
Tree-Pipit					<i>Acrocephalus schoenobaenus</i>	{ B.M.	1	—	1
<i>Anthus pratensis</i> (L.)	{ B.M.	1	2	3	(L.)	{ Ors.	—	—	1
Meadow-Pipit	{ Ors.	—	1	2	Sedge-Warbler				

* Includes various unpublished records as well as those from the literature.

† Doubtful host, designated as *Passer* sp.

TABLE 3—(cont.)

Host	Source of record	<i>C. gallinae</i>	<i>C. garei</i>	<i>D. g. gallinulae</i>	Host	Source of record	<i>C. gallinae</i>	<i>C. garei</i>	<i>D. g. gallinulae</i>
<i>Sylvia nisoria</i> (Bechst.) Barred Warbler	Ors.	1	—	—	<i>Strix aluco</i> (L.) Tawny Owl	{ B.M. Ors.	5 1	— —	— —
<i>Sylvia borin</i> (Bodd.) Garden Warbler	{ B.M. Ors.	— 1	— —	1 —	<i>Tyto alba</i> (Scop.) Barn-Owl	B.M.	4	—	—
<i>Sylvia atricapilla</i> (L.) Blackcap	Ors.	—	—	2	<i>Accipiter nisus</i> (L.) Sparrow-Hawk	{ B.M. Ors.	4 1	— —	1 —
<i>Sylvia communis</i> Lath. Whitethroat	{ B.M. Ors.	— 1	— —	1 4	<i>Anas platyrhynchos</i> L. Mallard	{ B.M. Ors.	— —	3 1	— —
<i>Sylvia curruca</i> (L.) Lesser Whitethroat	B.M.	—	—	1	<i>Anas acuta</i> L. Pintail	{ B.M. Ors.	— —	1 2	— —
<i>Turdus viscivorus</i> L. Mistle-Thrush	{ B.M. Ors.	1 3	— —	2 2	<i>Spatula clypeata</i> (L.) Shoveler	B.M.	—	1	—
<i>Turdus ericetorum</i> Turton Song-Thrush	{ B.M. Ors.	4 6	— 3	4 5	<i>Aythya fuligula</i> (L.) Tufted Duck	B.M.	—	2	—
<i>Turdus merula</i> L. Blackbird	{ B.M. Ors.	16 6	2 2	15 12	<i>Somateria mollissima</i> (L.) Common Eider	{ B.M. Ors.	— —	3 1	— —
<i>Oenanthe oenanthe</i> (L.) Wheatear	{ B.M. Ors.	— —	— 1	1 4	<i>Melanitta nigra</i> (L.) Common Scoter	B.M.	—	1	—
<i>Saxicola torquata</i> (L.) Stonechat	{ B.M. Ors.	— —	— —	1 1	<i>Mergus serrator</i> L. Red-breasted Merganser	B.M.	—	1	—
<i>Phoenicurus phoenicurus</i> (L.) Redstart	{ B.M. Ors.	2 1	— —	3 2	<i>Phalacrocorax aristotelis</i> (L.) Shag	B.M.	—	3	—
<i>Phoenicurus ochrurus</i> (L.) Black Redstart	Ors.	1	—	—	<i>Hydrobates pelagicus</i> (L.) Storm-Petrel	B.M.	1	—	—
<i>Erihacus rubecula</i> (L.) Robin	{ B.M. Ors.	1 3	— —	14 19	<i>Fulmarus glacialis</i> (L.) Fulmar Petrel	{ B.M. Ors.	1 —	— —	1 1
<i>Prunella modularis</i> (L.) Hedge-Sparrow	{ B.M. Ors.	5 9	1 —	10 7	<i>Columba palumbus</i> L. Wood-Pigeon	{ B.M. Ors.	1 —	— 1	— 1
<i>Troglodytes troglodytes</i> (L.) Wren	{ B.M. Ors.	4 8	— —	8 8	<i>Columba oenas</i> L. Stock-Dove	{ B.M. Ors.	1 3	— —	— —
<i>Cinclus cinclus</i> (L.) Dipper	{ B.M. Ors.	3 1	— —	6 —	<i>Columba livia</i> Gm. Rock-Dove	{ B.M. Ors.	3 4	1 —	1 1
<i>Hirundo rustica</i> L. Swallow	{ B.M. Ors.	4 5	— 1	— —	<i>Scolopax rusticola</i> L. Woodcock	B.M.	—	—	1
<i>Delichon urbica</i> (L.) House-Martin	{ B.M. Ors.	8 3	— —	— —	<i>Capella gallinago</i> (L.) Snipe	{ B.M. Ors.	— —	3 1	— —
<i>Riparia riparia</i> (L.) Sand-Martin	B.M.	1	—	—	<i>Calidris alpina</i> (L.) Dunlin	B.M.	—	1	—
<i>Apus apus</i> (L.) Swift	{ B.M. Ors.	3 1	— —	— —	<i>Tringa totanus</i> (L.) Redshank	B.M.	—	1	—
<i>Picus viridis</i> L. Green Woodpecker	B.M.	1	—	—	<i>Charadrius hiaticula</i> L. Ringed Plover	B.M.	—	2	—
<i>Dryobates major</i> (L.) Great Spotted Woodpecker	Ors.	1	—	—	<i>Vanellus vanellus</i> (L.) Lapwing	{ B.M. Ors.	— —	4 1	1 —
<i>Jynx torquilla</i> L. Wryneck	B.M.	1	1	—	<i>Sterna macrura</i> Naumann Arctic Tern	B.M.	—	1	—
<i>Athene noctua</i> (Scop.) Little Owl	{ B.M. Ors.	2 3	— —	— —	<i>Larus ridibundus</i> L. Black-headed Gull	B.M.	—	1	—
<i>Asio otus</i> (L.) Long-eared Owl	{ B.M. Ors.	2 1	— 1	— —	<i>Larus canus</i> L. Common Gull	B.M.	—	1	—
					<i>Larus fuscus</i> L. Lesser Black-backed Gull	B.M.	—	2	—

TABLE 3—(cont.)

Host	Source of record	<i>C. gallinae</i>	<i>C. garei</i>	<i>D. g. gallinulae</i>	Host	Source of record	<i>C. gallinae</i>	<i>C. garei</i>	<i>D. g. gallinulae</i>
<i>Larus marinus</i> L.	Ors.	—	1	—	<i>Lagopus scoticus</i> (Lath.)	B.M.	—	2	2
Great Black-backed Gull					Red Grouse		Ors.	1	3
<i>Rissa tridactyla</i> (L.)	Ors.	1	—	—	<i>Phasianus colchicus</i> L.	B.M.	2	5	3
Kittiwake					Pheasant	Ors.	—	2	—
<i>Stercorarius parasiticus</i> (L.)	B.M.	—	1	—	<i>Perdix perdix</i> (L.)	B.M.	—	4†	—
Arctic Skua					Common Partridge	Ors.	—	2†	—
<i>Fratercula arctica</i> (L.)	Ors.	1	1	1	<i>Alectoris rufa</i> (L.)	B.M.	—	1	—
Puffin					Red-legged Partridge				
<i>Crex crex</i> (L.)	B.M.	—	2	—	<i>Gallus domesticus</i> L.	B.M.	13	—	—
Corn-Crake					Fowl		Ors.	23	1
<i>Gallinula chloropus</i> (L.)	B.M.	1	4	4					
Moorhen					Ors.	—	1	2	

† This is an under-estimate since two of these six records were 'from several nests'.

in the nests of the Phasianidae and Tetraonidae (Game-birds), from which there are nineteen records as opposed to six of *D. g. gallinulae* and three of *C. gallinae*. It is also found more frequently in the nests of the Laridae than either of the other two species. In Britain it is the only flea recorded from the Linnet (*Carduelis spinus*) and the Bearded Tit (*Panurus biarmicus*), and despite the paucity of records it may be considered the dominant species in the nests of the Reed-Bunting (*Emberiza schoeniclus*). This list is sufficient to show *C. garei*'s predilection for ground-nesting species which favour damp sites and build open nests. Nevertheless, it has been collected from the nests of a great variety of birds, and Table 3 shows that it has been recorded more than once from the Starling (*Sturnus vulgaris*), Blackbird (*Turdus merula*), and Song-Thrush (*Turdus ericetorum*). There are some curious omissions from its list of hosts in Britain. One would expect a number of records from the Swan, the Herring-Gull, Dipper, Wren, and Robin, but *C. garei* has never been recorded from any of these birds in Britain, although there is one specimen in the C. Rothschild collection from *Troglodytes troglodytes* in Germany.

It appears that nests of the Wren (*Troglodytes troglodytes*) and Robin (*Erithacus rubecula*) present optimum conditions for *D. g. gallinulae*. Whatever these conditions may be—and the difference between the microclimate presented by a Robin's nest and a Linnet's nest appears superficially to be rather slight—they possibly prove unsuitable for *C. garei*. In these circumstances competition from *D. g. gallinulae* may prove too strong. On the other hand, host preference of the imago and not the requirements of the developmental stages may in part account for this distribution. It is less curious that there is only one record from the ground-bird *par excellence*, the domestic fowl, since it nests under exceptionally dry conditions.

As is pointed out in Table 4, *C. garei* occurs less frequently on the bodies of its hosts than either *C. gallinae* or *D. g. gallinulae*. Unfortunately the relevant data are often omitted both in the literature and on labels on slides, but certain entomologists such as James Waterston always noted whether specimens came from

the body or nest of their host. In other cases collectors like W. H. Pollen and F. J. Cox can supply the necessary data. Generally speaking, if a flea is collected from the body of a bird the fact is considered of interest and is therefore noted, so most of the material without specific information on this point comes from nests. In the Charles Rothschild collection (Table 9) there is a batch of male and female *C. garei* which bears this label: 'Found by taxidermist in Natural History Museum, London. Land-Rail.' Although there is no mention of the body of the host, in this

TABLE 4

*Comparative Records of C. gallinae, C. garei, and D. g. gallinulae (compiled from all known British records)**

Species of flea	<i>C. gallinae</i>	<i>C. garei</i>	<i>D. g. gallinulae</i>
Total number of records	363	108	266
Number of known species of bird-hosts in Britain.	65	49	59
Percentage on Passerine hosts	86	35	92
Number of records from body of host. (<i>Note:</i> Many of these records are of more than one specimen)	58 (16 per cent. of total records)	10 (9 per cent. of total records)	57 (21 per cent. of total records)
Proportion of sexes on body of host	60 ♀ 37 ♂	8 ♀ 2 ♂	33 ♀ 31 ♂
Proportion of sexes in nest (only collections in B.M. of under 20 specimens counted)	315 ♀ 188 ♂	77 ♀ 69 ♂	216 ♀ 126 ♂
Percentage of collections (from individual nests) in B.M. with over 20 specimens per nest†	31 per cent.	30 per cent.	13 per cent.

* These include unpublished records kindly supplied by various authors (see acknowledgements). Records away from a host, from mammalian hosts, or from unspecified birds' nests are omitted.

† In actual fact the percentage is probably much higher, since collectors often preserve a small fraction only of the specimens they find in a nest.

case I have assumed that these specimens were collected from the bird itself. Apart from this one batch of fleas, only specimens definitely known to have come from the host are counted in line 5 of Table 4. Since the totals in line 1 contain a number of records in which the relevant data are missing altogether, the figures for the number of fleas from the bodies of birds may be on the low side, but this should not affect the relative frequency of the three species concerned. Furthermore, there are a number of records in which no host is named at all: 'Found in old bird's nest', or 'From old nesting box' are all-too-familiar labels. Since these have been omitted as well as the records of 'free' specimens, there is probably adequate compensation for the odd flea which may have come from the body of its host and for which there are no available data. Altogether it seems likely that these figures, 9 per cent., 16 per cent., and 21 per cent., give a fair picture of the relative frequency of the three common bird-fleas on the bodies of their hosts.

There are inadequate numbers (ten specimens only) for comparing the ratio of the sexes for this species. With this point in mind, fifty-six collections of *C. garei* (from the British Museum) from nests of named bird hosts were examined. Thirty-

nine contained less than twenty specimens per nest, and the sex-ratio was 69 males to 77 females. The remaining seventeen collections contained more than twenty fleas per nest, and three collections out of these showed a great preponderance of females. One of the heavy infestations came from the nest of the Bearded Tit (*Panurus biarmicus*), and others were from Anatidae (four), *Perdix perdix* (three), and *Phalacrocorax aristotelis* (two).

In a previous paper (Rothschild, 1948) I described *C. garei* as a 'circumpolar species extending southwards to central Europe and through Alaska and Canada to the western United States'. It is well distributed on the mainland of Britain, but according to O'Mahony (1948) is relatively scarce in Ireland. This point is further discussed on page 212.

2. *Ceratophyllus gallinae* (Schrank) 1803. There are thirty-two separate records of this flea in the collection, but in actual numbers it exceeds *D. g. gallinulae*—fifty-two specimens compared with forty-four. *C. gallinae* has a sound claim to be the commonest bird-flea in Britain. It occurs on a greater variety of hosts, and the total number of records from birds in Britain (excluding the Fowl) about equals

TABLE 5

Selected Hosts on which C. garei is the Dominant Species of Flea

Name of host	<i>C. garei</i> records	<i>C. gallinae</i> records	<i>D. g. gallinulae</i> records
<i>Carduelis cannabina</i> (L.) . . . Linnet	3	0	0
<i>Panurus biarmicus</i> (L.) . . . Bearded Tit	2	0	0
<i>Anas platyrhyncha</i> L. Mallard	4	0	0
<i>Somateria mollissima</i> (L.) . . . Common Eider	4	0	0
<i>Capella gallinago</i> (L.) Snipe	4	0	0
<i>Vanellus vanellus</i> (L.) Lapwing	5	0	1
<i>Perdix perdix</i> (L.) Common Partridge (three of these records are from 'several nests')	6	0	0

the combined collections of both *C. garei* and *D. g. gallinulae*. Moreover, a higher proportion of *C. gallinae* infestations may be described as heavy. It will be seen from Table 4 that 16 per cent. of the total records were from the body of the host, less than in the case of *D. g. gallinulae* but significantly more than in that of *C. garei*. It is also interesting that in this collection the number of female fleas on the host outnumbers the males by approximately 3:2, whereas they are about equal in the case of *D. g. gallinulae*. In eighty-one collections from named birds' nests (see Table 4) the sex-ratio was also approximately 3:2.

In the 'Synopsis of the British Siphonaptera' (Rothschild, 1915) the hosts of *C. gallinae* are given as 'the fowl and many birds', and again 'in the nests of most

birds and hen-houses'. In 1930 Wagner was more precise and lists: 'Birds, principally *Gallus*, *Passer*, *Parus*'. Freeman (1941) takes a wider view and considers that *C. gallinae* favours 'almost all birds'.

It is shown in Table 4 that (excluding collections from the Fowl) 86 per cent. of British records of *C. gallinae* are from Passerine birds. It does not occur on the Anatidae (two specimens recorded in the continental literature from ducks have not been checked and are probably errors in determination) or Scolopacidae and there is only one record each in Britain from the Rallidae and Laridae. The wild Jungle Fowl (*Gallus gallus* L.) is not infested with *C. gallinae*, and Jordan (1928) suggests that the domestic fowl is a secondary host and that the primary hosts in Europe may be the Paridae.

If we examine the list of records in Table 3 it will be noted that, despite the wide range of hosts, *C. gallinae* is much more common in the nests of birds which build in holes and some distance from the ground. These nests (as well as hen-houses) are almost certainly drier than those built in low situations. Thus *C. gallinae* is the dominant species in the nests of such birds as the Starling, House-Sparrow, Jackdaw, and Blue-Tit (see Tables 3, 6, and 9).

TABLE 6

Selected Hosts on which C. gallinae is the Dominant Species of Flea

Name of host	<i>C. gallinae</i> records	<i>C. garei</i> records	<i>D. g. gallinulae</i> records
<i>Corvus corone</i> L. Carrion-Crow	7	1	1
<i>Sturnus vulgaris</i> L. Starling	42	2	6
<i>Passer domesticus</i> (L.) House-Sparrow	46	0	3
<i>Parus major</i> L. Great Tit	25	0	9
<i>Parus coeruleus</i> L. Blue-Tit	36	0	4
<i>Strix aluco</i> L. Tawny Owl	6	0	0
<i>Athene noctua</i> (Scop.) Little Owl	5	0	0
<i>Accipiter nisus</i> (L.) Sparrow-Hawk	5	0	1

Out of the thirty-eight collections (from the British Museum) which contain more than twenty specimens per nest, eighteen came from *Parus* spp., six from *Passer domesticus*, and five from *Sturnus vulgaris*.

C. gallinae is widely distributed in Europe and in parts of Asia. There are specimens in the British Museum collection from France, Holland, Switzerland, Germany, Austria, Hungary, Roumania, Russia, north China, Mongolia, and east Turkestan. The species has probably been introduced into the United States and certainly into New Zealand, and has passed on to various species of indigenous hosts. Its range in

the United States is restricted to the eastern States. It is found more frequently than other bird-fleas as a straggler on mammals. It is also recorded quite frequently away from any host (see Table 8), and has been noted by Waterston (1910) migrating from nests in impressive swarms. Bacot (1914) and Ioff (1946) have shown that this species can survive over a year in empty bird-nests. Although it seems clear that *C. gallinae* may pass the winter on the body of its host and thus be transported back to the new nest when it is built, it is likely that birds can also be reinfested at their nesting-sites in the spring by fleas which have over-wintered under the bark of trees and in piles of rubbish, dead leaves, or old nesting-holes.

3. *Dasypsyllus gallinulae gallinulae* (Dale) 1878. Miss Clay and Colonel Meinertzhagen collected thirty-five records of this interesting species. It is shown in Table 4 that *D. g. gallinulae* occurs in a higher proportion on the bodies of birds than the other two common species, and also that 92 per cent. of its hosts are Passerines. These two facts are sufficient to account for its preponderance in the collection. It will be noted, for instance, that if all records of fleas from *Parus major* are pooled (Table 3), we find that *C. gallinae* exceeds *D. g. gallinulae* on this host by about 3:1, yet in this collection (Table 1) the reverse is true, and the ratio is 1:2.

The distribution of this species is one of considerable interest. The genus *Dasypsyllus* is essentially Neotropical, and *D. g. gallinulae* is the one representative in Britain of a characteristic South American genus. There are five species recorded from ground-nesting birds in Chile, Brazil, and the Argentine; one species in Sumatra on rats (probably an accidental host); and *D. stejnegeri* is known from Behring Isle and Commander Isle, Siberia, St. Paul Island (Pribilof Group), Alaska, and Langara Isle, Queen Charlotte's (British Columbia), and is probably parasitic on sea-birds, though the host is unknown (Jordan, 1929, and Holland, 1949). *D. g. gallinulae* is represented in Mexico, the U.S.A., and Canada by a subspecies, *D. g. perpinnatus* Baker, 1904. It is confined to the Pacific coast of the North American continent, although many of its bird hosts extend their range far eastwards. It is suggested by Holland (1949: 30) that 'this flea requires a type of nest (the exact genus or species of the bird host not being important) in country supporting a climate with a relatively high mean humidity, and perhaps certain temperature limits. As the nests of most Passerines are open and exposed directly to the atmosphere, it may be quite readily seen that it is possible for the humid atmosphere of the coast to present suitable breeding conditions for these fleas, whereas the dry climate and more extreme temperatures of the interior of British Columbia, even though the same birds were nesting, would prohibit development.' Limitation of distribution of this type thus is almost undoubtedly controlled by factors which affect the flea larva rather than the adult.' This seems a sound hypothesis, and the distribution of *D. g. gallinulae* among bird hosts in Britain gives us a hint that it, too, may not be able to survive in dry nests.

C. gallinae is the dominant species in relatively dry nests which are built in holes or in the open but some distance from the ground, and *C. garei* is characteristic of ground-nesting species, especially those which favour damp sites, whereas *D. g. gallinulae* is found most commonly in the nests of Passerine birds building near the ground. The flea fauna of the Paridae in Britain present an excellent example of

this fact, since *C. gallinae* is predominant in nests of the Blue-Tit (*Parus coeruleus*) and Great Tit (*Parus major*), *C. garei* in the nests of the Bearded Tit (*Panurus biarmicus*), and *D. g. gallinulae* in the nests of the Long-tailed Tit (*Aegithalos caedatus*). *D. g. gallinulae* is also dominant in nests of the Robin, Redstart, Willow-Warbler (*Phylloscopus trochilus*), and Greenfinch (*Chloris chloris*). There are no records at all of this flea from the Hirundinidae, Strigidae, Laridae, or Anatidae, and none, either, from the Fowl; however, it exceeds all others on the Sylviidae, with 23 records against 7 of *C. gallinae* and 2 of *C. garei*, and on the Turdidae with 85 records against 44 and 8 respectively.

Since we know nothing of the relative humidity of any nests, this suggestion must not be pushed too far. Moreover, the number of records from various hosts is too small to be significant. It is also obvious that the overlap between all these three species of fleas, particularly *C. gallinae* and *D. g. gallinulae*, is considerable (see Table 3), and there are several instances which run directly contrary to this theory. Thus there are more records of *D. g. gallinulae* than of *C. garei* in the nests of both the Moorhen and Dipper. There is an equal number of records of *C. gallinae* and *D. g. gallinulae* from the Mistle-Thrush (*Turdus viscivorus*), although the former has a 10:9 majority over *D. g. gallinulae* in nests of the Song-Thrush (*Turdus ericetorum*). Despite these and numerous other contradictions, the data contained in Table 3, meagre though they are, suggest that all these three common species of bird-flea, not only *C. garei*, have a preference for birds favouring certain types of nesting sites.

TABLE 7

Selected Hosts on which D. g. gallinulae is the Dominant Species of Flea

Name of host	<i>D. g. gallinulae</i> records	<i>C. gallinae</i> records	<i>C. garei</i> records
<i>Chloris chloris</i> (L.) . . . Greenfinch	9	2	0
<i>Fringilla coelebs</i> L. . . . Chaffinch	10	5	1
<i>Phylloscopus trochilus</i> (L.) . . . Willow-Warbler	8	0	0
<i>Sylvia communis</i> Lath. . . . Whitethroat	5	1	0
<i>Turdus merula</i> L. Blackbird	27	22	4
<i>Erithacus rubecula</i> (L.) . . . Robin	33	4	0
<i>Troglodytes troglodytes</i> (L.) . . . Wren	16	12	0
<i>Gallinula chloropus</i> (L.) . . . Moorhen	6	1	5

D. g. gallinulae is not found in such large numbers in the nests of birds as either *C. gallinae* or *C. garei* (see Table 4). Out of ninety-three batches from the nests of named bird hosts in the British Museum collection, only 13 per cent. contained more

than ten specimens of either sex. The hosts which are most heavily infested numerically are the Warblers and the Robin, which are also the hosts with the relatively largest number of records. One heavy infestation came from the nest of the Moorhen, proving that this species can breed successfully in what appear to be especially damp nests.

The numbers of the sexes of *D. g. gallinulae* on the body of the host is almost equal (see Table 4), but in the nest there is a heavy preponderance of females—216:126 in the eighty batches counted.

The range of *D. g. gallinulae* on the continent of Europe is not known with any accuracy. In the British Museum collection there are specimens from France, Holland, Germany, Switzerland, Portugal, Italy, Roumania, Iceland, the Azores, Madeira, and a pair from the Nepal-Sikkim frontier of northern India.

TABLE 8

*British Records of C. gallinae, C. garei, and D. g. gallinulae
collected away from any Host or Nest*

<i>Species of flea</i>	<i>Location</i>	<i>Locality</i>	<i>Date</i>	<i>Collector</i>	<i>Collection</i>
<i>C. gallinae</i> (3 ♂, 3 ♀)	Refuse dump	N. Ireland	1939	Received from Dept. of Agri- culture	Rothschild Coll. (B.M.)
<i>C. gallinae</i> (1 ♀)	Dead leaves in orchard	Kennetpans, Kincardine on Forth	1914	British Museum	„
<i>C. gallinae</i> (1 ♀)*	Beneath beech bark	Hylton Bridge, Sunderland	7.xi.05	R. S. Bagnall	„
<i>C. gallinae</i> (1 ♀)	In rotten oak- tree	Sherwood	30.v.27	C. E. Stott	„
<i>C. gallinae</i> (1 ♂, 3 ♀)	In hollow tree	Wroxeter, Uppington, Shropshire	23.viii.12	G. A. K. Marshall	„
<i>C. gallinae</i> (many)	Found in a garden	Newport, Shropshire	x.49	J. Maclagan	„
<i>C. gallinae</i> (1 ♂, 1 ♀)	From keeper's larder	Leicester	3.iv.1899	H. B. Headley	„
<i>C. gallinae</i> (many)	On palings	Leicester	17.iv.1899	H. B. Headley	„
<i>C. gallinae</i> (1 ♂)	In moss	Oxford	6.iii.1897	J. Shipp	„
<i>C. gallinae</i>	Warehouse	Manchester	1930	H. R. P. Collett	H. Britten
<i>C. gallinae</i> (many)	Under bark of beech-trees	Hylton, Co. Durham	v.09	R. S. Bagnall	One specimen Rothschild Coll. (B.M.)
<i>C. gallinae</i> (2 ♂, 3 ♀)	Cruciferous plant	Gibside, Co. Durham	v.09	R. S. Bagnall	Bagnall Coll.
<i>C. gallinae</i> (1 ♀)	Stump of <i>Sorbus aucuparia</i>	Drum, Aberdeen- shire	15.v.42	G. D. Morison	Morison Coll.
<i>C. gallinae</i> (1 ♀)	Dead leaves in glasshouse	Brodie, Nairn, Morayshire	20.ii.45	„	„

* Although there is only one specimen in the Rothschild Collection, Bagnall (1921) records it 'in numbers under beech tree bark' (Bagnall, R. S., *Trans. Nat. Hist. Soc. Northumberland & Durham*, 1921, 5: 181-198).

TABLE 8—(cont.)

Species of flea	Location	Locality	Date	Collector	Collection
<i>C. gallinae</i> (in numbers)	In barns	Holton, Suffolk	1913	Strickland and Merriman	} †
<i>C. gallinae</i>	Hole in an oak- tree	Holton, Suffolk	1913	Strickland and Merriman	
<i>C. gallinae</i> (1 ♀)	From <i>Vespa</i> <i>vulgaris</i>	Harpenden, Herts.	17.iii.21	R. Stenton (Min. of Agr.)	British Museum
<i>C. garei</i> (1 ♂)	Sandhills	Hynish, I. of Ti- ree, Argyllshire	30.iv.12	H. Donisthorpe	Rothschild Coll. (B.M.)
<i>C. garei</i> (1 ♀)	In a stack of reeds	Funton, nr. Iwade, Kent	19.iii.98	J. J. Walker	"
<i>C. garei</i> (1 ♂, 2 ♀)	Haystack refuse	Hunstanworth, Co. Durham	?	R. S. Bagnall	Bagnall Coll.
<i>D. g. galli- nulae</i> (2 ♀)	In a cave on sea cliffs	Donegal, Ireland	vii.22	E. E. Austen	Rothschild Coll. (B.M.)
<i>D. g. galli- nulae</i> (3 ♀)	Among stones in cave in sea cliffs	Near Portsalon, Lough Swilly, Co. Donegal	8.viii.22	G. C. C. Damant	"
<i>D. g. galli- nulae</i> (3 ♂, 5 ♀)	Read's Cavern	Burrington Coombe, Men- dip Hills, N. Som.	4.v.40	G. A. Walton	"
<i>D. g. galli- nulae</i>	In grass	Rainow, Cheshire	7.vi.19	F. Neave	H. Britten
<i>D. g. galli- nulae</i>	Swept off <i>Vac- cinium</i>	Long Hill, Co. Wicklow	21.v.23	A. W. Stelfox	Nat. Mus., Dublin
<i>D. g. galli- nulae</i> (1 ♀)	Dry bark of cherry-tree	Craibstone, Aberdeen	5.iv.43	G. D. Morison	Morison Coll.
<i>D. g. galli- nulae</i> (1 ♀)	Herbage	Craibstone, Aberdeen	1.v.41	"	"
<i>D. g. galli- nulae</i> (1 ♀)	Pine log	Drum, Aberdeen	15.v.42	"	"
<i>D. g. galli- nulae</i> (1 ♀)	Among herbage	Newtonhill, Kincardine	21.v.49	"	"

† These records were published in *Parasitology*, 1913, 6 (1): 1-19 (Observations on British rat-fleas, by G. H. F. Nuttall, C. Strickland, and G. Merriman), but the whereabouts of the specimens is not known.

D. STRAGGLERS FROM MAMMALIAN HOSTS

1. *Nosopsyllus fasciatus* (Bosc. D'Antic) 1801. One specimen was collected from *Troglodytes t. troglodytes* in Arran. The normal host is the Brown Rat (*Rattus norvegicus*). There are three females and one male of this species in the British Museum collection from a Blackbird's nest in Holland (Smit, 1949).

2. *Orchopeas wickhami* (Baker) 1895. One specimen of the Grey Squirrel flea, which was originally imported into this country from the U.S.A. with its host, *Sciurus carolinensis*, was collected from *Parus major newtoni* Prazak. This species of flea is a more frequent straggler on to avian hosts. In the Charles Rothschild collection there are specimens collected from 'a Magpie's and Hawk's nest', and an unnamed bird's nest in the New Forest, Hampshire. An exchange of fleas between birds and squirrels is, in fact, a usual accident, and *Monopsyllus sciurorum* (Schränk) 1803 has been known to breed in large swarms in an Owl's nest (Waterston, 1910),

while *C. gallinae* has frequently been recorded breeding in Squirrels' dreys in Britain, although not in large numbers (Freeman, 1941).

SOME GENERAL CONSIDERATIONS RELATING TO *C. GALLINAE*,
C. GAREI, AND *D. G. GALLINULAE*

Geographical distribution. With regard to the three common species of bird-fleas *C. gallinae*, *C. garei*, and *D. g. gallinulae* in Britain, the maps in Figs. 1-3 all tell much the same story. These fleas are widely distributed throughout the British Isles and certain obvious concentrations mark the home territories of well-known collectors such as C. Rothschild, H. G. Jeffrey, R. Newstead, H. Britten, and J. Waterston. In Ireland, according to E. O'Mahony, *C. garei* is relatively scarce, but unless lists of negative records are provided such statements may be somewhat misleading. If a long series of Ducks' nests, or Snipes' nests, yielded no specimens of *C. garei* this would be significant. In Cornwall, Turk (1946) considered *C. gallinae* 'not so common as it seems to be in other counties. Its place seems to be taken by *D. gallinulae*, which is a very common species. . . . I have records from many small Passerine birds and from Blackbirds, the domestic pigeon and the Wood-Pigeon.' However, if we pool all records for the British Isles (see Table 3), *D. g. gallinulae* is seen to be the dominant species in the nests of the Blackbird (G. B. Thompson, 1937, records 350 specimens from one nest), and the same may apply to the unnamed 'small Passerines' to which Turk refers earlier. Since going to press Dr. Turk has sent me a list of these species. They include the Robin, Wren, and Tree-Creeper, in which *D. g. gallinulae* is usually dominant; the Thrush, Mistle-Thrush, and Goldcrest, in which nests both species have been recorded an approximately equal number of times; and the Great Tit, Blue-Tit, Jackdaw, Carrion-Crow, Raven, and Rook, in which nests *C. gallinae* is usually the dominant species of flea. In all, Dr. Turk found *D. g. gallinulae* 'in nearly a hundred nests'. In Ireland O'Mahony (1939) has come to a somewhat similar conclusion with regard to these two species, namely that *D. g. gallinulae* is 'the commoner of the two in point of numbers', but again the seven species of birds' nests he has listed in which *D. g. gallinulae* outnumber *C. gallinae* include the Wren, the Greenfinch, the Chaffinch, the Mistle-Thrush, the Song-Thrush, and the Blackbird. *D. g. gallinulae* is usually dominant in five of these, and in the nest of the Song-Thrush the two species are about equally represented (see Tables 3 and 6). He did not record *D. g. gallinulae* at all from nests of the House-Sparrow or the Blue-Tit—records which would have been far more significant. It would be of much interest if further collecting in the west of England and Ireland confirmed the suggestions made by O'Mahony and Turk, since the distribution of *D. g. gallinulae* among its hosts in Britain and the distribution of the subspecies *D. g. perpinnatus* in North America suggest that it requires rather a high mean humidity in the nest. Thus it might possibly increase the range of its Passerine hosts where the mean annual rainfall is greater, and also occur in larger numbers in the nests of certain species where it is numerically sparse in drier conditions. In the meantime, however, the distribution maps of *C. gallinae*, *C. garei*, and *D. g. gallinulae* (Figs. 1, 2,

and 3) show the distribution of the collectors rather than that of the fleas, and indicate that all three species occur where they are looked for.

A few observations on the distribution of *C. vagabunda* and the Martin fleas are included in the description of the collection on pages 195 and 196. With all the species concerned further collecting is necessary before any conclusions can be drawn. From the little we know, however, it is obvious that the flea fauna of Scotland is of considerable interest. There are several species, such as *C. borealis*, *Orneacus waterstoni*, and *Frontopsylla laetus*, which display a so-called alpine-boreal type of distribution, occurring in Scotland and the Swiss Alps and in some cases along the northern fringe of Europe, but not apparently in England or the intervening areas of the Continent. This type of distribution is even more striking in the case of fleas than in other insects, since the host itself is widely distributed. On the other hand, *C. hirundinis* occurs on the House-Martin throughout its range. It is, however, clear, as we have seen in the case of *D. g. perpinnatus*, that other factors limit the distribution of the fleas, presumably requirements of the developmental stages. Although many of the Passerine hosts of bird-fleas migrate to South Africa and other warm countries in the winter, and (we may surmise) take their fleas with them, the Ceratophyllid bird-fleas have remained a group which is characteristic of temperate climates.

In east Africa over a period of fourteen years, G. H. E. Hopkins and a team of his friends examined over 2,000 birds shot for food or scientific purposes. Ectoparasites were collected by the method described in the introduction. Not a single specimen of *Ceratophyllus* was found, thus confirming the fact that the apparent absence of this genus on birds, in tropical Africa at least, is genuine. It should be noted that a number of migrants were included in this collection. Thus fifteen specimens of the Sand-Martin (*Riparia riparia*) and six specimens of the Swallow (*Hirundo rustica*) were among the negative records. There were also smaller numbers of birds such as the European Cuckoo (*Cuculus c. canorus*), the Whinchat (*Saxicola rubetra*), the Green Sandpiper (*Tringa ochropus*), and the Wood Sandpiper (*Tringa glareola*).

Host-preference. Among the three species of common bird-fleas which are not host-specific we can discern two different trends of host-preference. On the one hand there is a marked predilection on the part of *D. g. gallinulae* and *C. gallinae* for the Order Passeriformes, and on the part of *C. garei* for the Charadriiformes, Anseriformes, and Galliformes. Within this framework we can—despite a big overlap and many exceptions—discern a preference for different types of nesting sites. Broadly speaking, *C. garei* favours damp nests on the ground, *D. g. gallinulae* those built near the ground, and *C. gallinae* nests built in drier situations some distance from the ground. There is also one generalization which may be made regarding the host relationship of all these three common species: those birds which are the most frequently infested and may be termed the favoured hosts are also the most heavily infested. Thus *C. gallinae*, which can breed in such a wide variety of nests, is found regularly in greatest numbers and obviously 'does best' in the nests of *Passer domesticus*, *Sturnus vulgaris*, *Parus*, and certain Strigidae. This fact is reflected in the number of specimens of *C. gallinae* collected from individual birds by

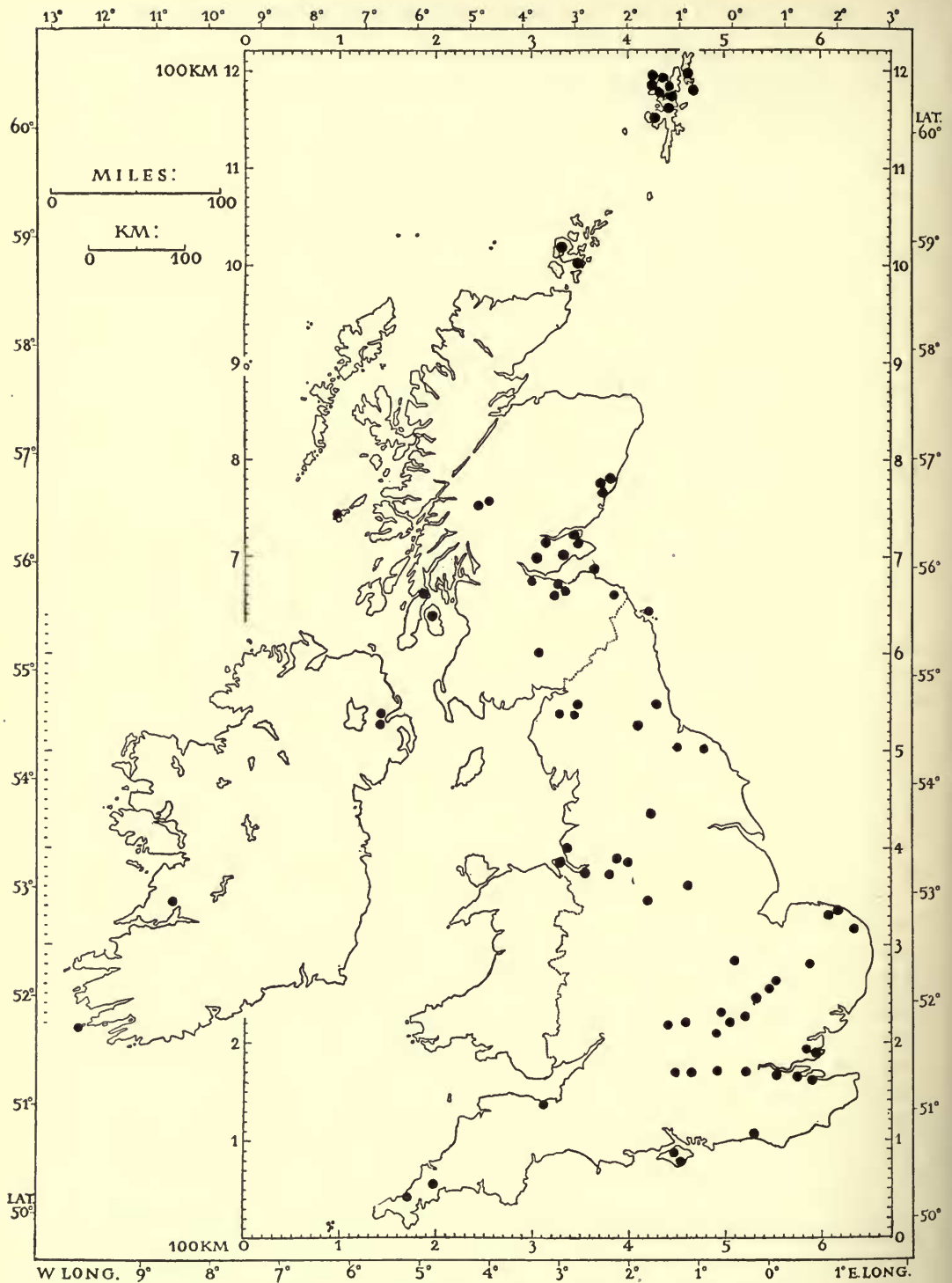


FIG. 1. Distribution map of *C. garei* in Britain, based on 108 records.

In the case of multiple records from one locality, for example twenty-three separate records of *C. gallinae* from Blue-Tits' nests in Cambridge, only one circle is used. This accounts for the fact that there are more records than circles on each map. Massed records of this type merely indicate intensive collecting in the area concerned, and have no bearing on the question of distribution.

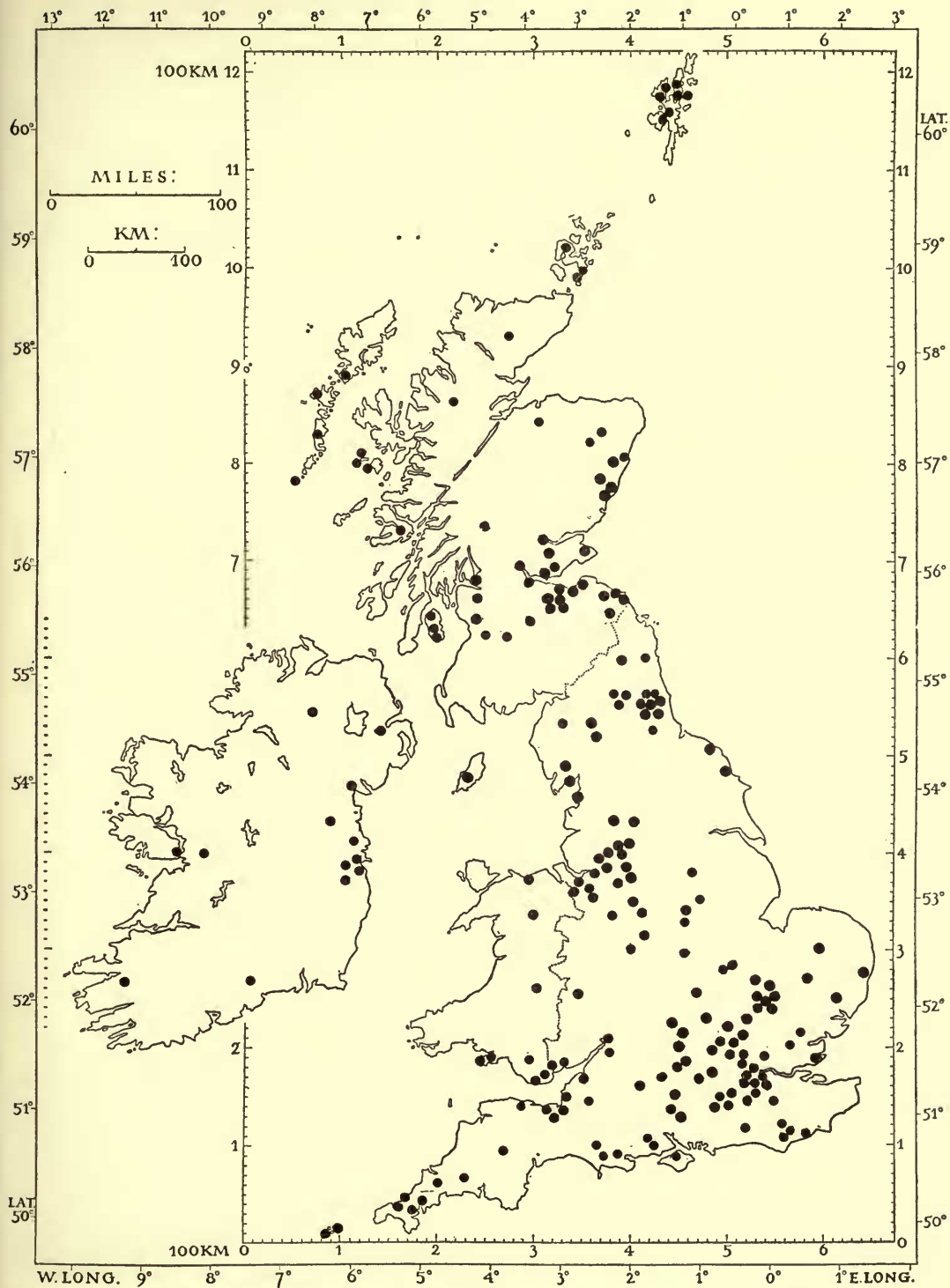


FIG. 2. Distribution map of *C. gallinae* in Britain, based on 363 records.

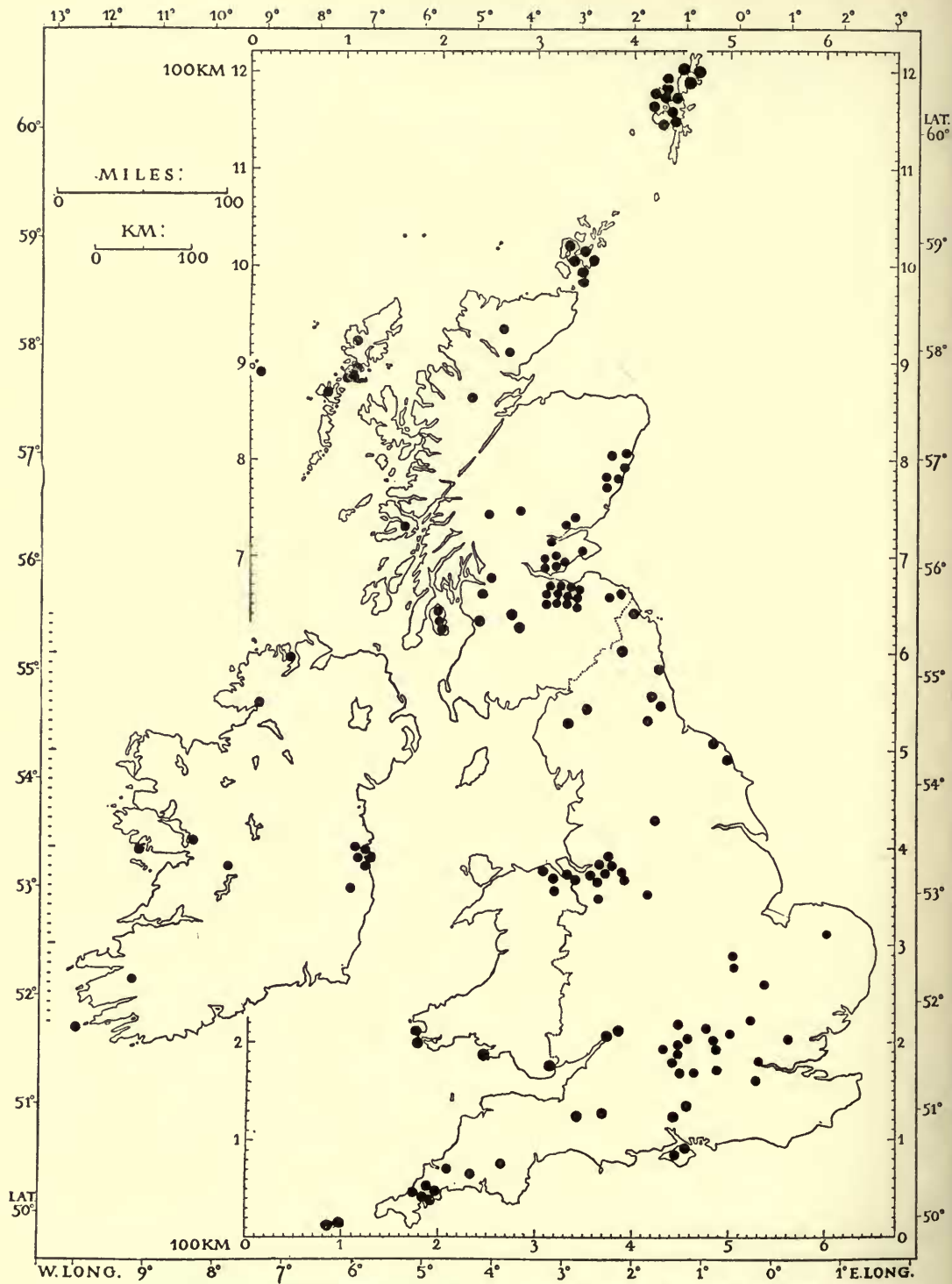


FIG. 3. Distribution map of *D. g. gallinulae* in Britain, based on 266 records.

Meinertzhagen and Pollen, thus six, four, and four specimens from Starlings, four, three, and two specimens from *Parus* spp., and nine and six specimens respectively from individual Little Owls (Tables 1 and 9).

Bacot (1914) has pointed out that in some cases egg-production of *Nosopsyllus fasciatus* falls off in drought, and Buxton (1938) has shown that in the case of *X. cheopis* 'even at one temperature and within tolerable limits of humidity the production of the first filial generation of fleas is closely dependent on humidity, the production being less as the fatal limit is approached'. Edney (1947) has shown that the life of the adult *X. brasiliensis* is shortened if the pupal stage is kept at low humidities, and these types of phenomena may account for the fact that all three common bird-fleas occur in smaller numbers in some nests than in others, only the favoured hosts providing the optimum conditions. It is of course possible that we are concerned with a combination of many factors, and not only the humidity requirements of the developmental stages. However, in this fact we can see indications of incipient or vestigial host-specificity—either a legacy from the past or a hint of things to come.

There are also indications of a third type of host-preference (such as we find in *C. vagabunda*) which at times seems to cut across the two main trends already mentioned. Undoubtedly certain birds appear to be more attractive or susceptible than others to one or all of the species concerned. Thus the Shag (*Phalacrocorax aristotelis*) and Cormorant (*Phalacrocorax carbo*) are placed in the same genus, and build the same type of nest in the same type of habitat, frequently in colonies which adjoin. There are three records of *C. garei* from the former (including one very heavy infestation where over 500 fleas were counted) and none at all from the latter. There are also more than six records from the Partridge (*Perdix perdix*)—a bird which is not infested with any other flea (Table 5). However, both *C. gallinae* and *D. g. gallinulae* as well as *C. garei* have been collected from the Pheasant (*Phasianus colchicus*) and Red Grouse (*Lagopus scoticus*). Here again there would appear to be little if any difference between these three nests, which are no more than sheltered scrapes lined with grass; in fact Pheasants and Partridges not infrequently lay in the same nest. It is also curious that *D. g. gallinulae* should have a marked predilection for the Moorhen (six records), since this bird is not a Passerine and (more important still) favours unusually damp nesting-sites.

The records from the Wood-Pigeon (*Columba palumbus*) suggest that this may also be a case in which the bird itself is attractive to fleas, since the type of nest it builds is exceptionally unsuitable for nidicoles. In Finland Nordberg (1936) has examined the nests of over fifty species of birds. He has shown that nests built in holes and what he terms 'half-holes' (*halbhölen Nester*) support the heaviest populations of nidicoles generally, and also the greatest variety of species. The Stock-Dove (*Columba oenas*) is one of the most heavily infested of all, with a total of fifty-eight species of nidicoles and 6,573 specimens per 1 dm.³ of nesting material. The Wood-Pigeon, with one species and only twenty specimens per 1 dm.³, is unquestionably the least infested out of all those he examined in Finland. In Britain there are only four records of *C. gallinae* from the Stock-Dove, but from the Wood-Pigeon we have records of the following species: *C. gallinae* (1—but 6 females

TABLE 9

C. gallinae, *C. garei*, and *D. g. gallinulae* in the British Museum (Natural History)
from named Bird Hosts

CORVIDAE

Corvus corone L. (*Carrion-Crow)

C. gallinae, 2 ♀, N. Wales, vii.30† (N. H. Joy), nest; 7 ♂, 11 ♀, Ashton, Oundle, 1919 (N. C. Rothschild), nest; Ashton, Oundle, summer, 1919 (J. Stuart), nest; 3 ♀, Ashton Wold, Oundle, vi.26 (F. J. Cox), nest; < ♂, < ♀, Layer Marney, Essex, v.36 (M. Rothschild), nest; Layer Marney, Essex, ix.36 (M.R.), nest; 1 ♀, Reading, vii.31 (N. H. Joy), nest; all Rothschild Coll.

Corvus monedula L. (Jackdaw)

C. gallinae, 4 ♂, 2 ♀, Colinton, Midlothian, 24.v.06 (J. Waterston), nest, B.M. 1914.517; < ♂, < ♀, Tring, Herts., summer, 1919 (N.C.R.), nest; Tring, Herts., viii.26 (K. Jordan), nest; 1 ♀, Bushey Park, 2.iv.06 (A. H. Bishop); 3 ♂, 2 ♀, Windsor Park, 22.xi.28 (H. Donisthorpe), nest; 1 ♂, 7 ♀, Norfolk, 24.iv.34 (W. H. Pollen), nest; 3 ♂, Ross-shire, 20.iii.34 (W. H. Pollen), body; 1 ♂, 1 ♀, Northampton, 1.v.35 (W. H. Pollen), body; *D. gallinulae*, 5 ♂, 4 ♀, Duncarn Hill, Fifeshire, 6.xi.09 (H. Ashworth), nest; all Rothschild Coll.

Pica pica (L.) (Magpie)

C. gallinae, 2 ♀, New Forest, 5.v.98 (B. G. Rye), nest, B.M. 98.88; 1 ♀, Essex, 16.i.35 (W. H. Pollen), body, Rothschild Coll.

STURNIDAE

Sturnus vulgaris L. (Starling)

C. gallinae, 3 ♂, 2 ♀, Little Roe Island, vii.10 (J. Waterston), nest; < ♂, < ♀, Ollaberry, vi.10 (J. Waterston), nest; Ollaberry, 16.iii.12 (J. Waterston), nest; Ollaberry, vi.12 (J. Waterston), nest; all B.M. 1914.517; 1 ♂, Aberdour, Fifeshire, 20.iv.07 (J. Waterston), nest; Rothschild

Coll.; 5 ♀, Woodburn House, near Dalkeith, 12.v.08 (J. Waterston (?)), nest; B.M. 1914.517; 1 ♂, Wiltshire, 14.iv.34 (W. H. Pollen), body; Rothschild Coll.; 2 ♂, 2 ♀, Northampton, 1.xii.34 (W. H. Pollen), body; Rothschild Coll.; 1 ♂, 10 ♀, Colinton, Midlothian, 19.v.09 (J. Waterston), nest; 10 ♂, < ♀, Arniston, Midlothian, 28.v.09 (A. Bennett), nest; 8 ♂, < ♀, Loudoun, Ayrshire, 17.vi.09 (J. Gloag), nest; all B.M. 1914.517; 7 ♂, 8 ♀, Armitage, Staffs., 24.iii.28 (C. E. Stott), nest; 2 ♂, 2 ♀, Ince, Cheshire, 1890 (R. Newstead); < ♂, < ♀, Ashton, Oundle, 5.vi.06 (F. J. Cox); Ashton, Oundle, 11.v.09 (F. J. Cox); Ashton, Oundle, v.10 (F. J. Cox), nest; Ashton, Oundle, vii.26 (F. J. Cox), nest; Ashton, Oundle, v.27 (F. J. Cox), nest; 2 ♀, Boxmoor, Herts. (A. Piffard); < ♂, < ♀, Tring, 7.vii.1900 (N.C.R.), nest; Tring, vi.01 (N.C.R.), nest; Tring, 10.vii.01 (N.C.R.), nest; 1 ♂, 6 ♀, Netherfield, Sussex, 1.vii.07 (W. R. Butterfield); 8 ♂, 6 ♀, Hastings, Sussex, 1909 (W. R. Butterfield); 3 ♂, 1 ♀, Reading, Berks., 9.vi.39 (B. T. Parsons), nest; 1 ♂, Brockenhurst, Hants., 28.v.06 (B. Piffard); < ♂, < ♀, Newport, I.O.W., v.10 (H. G. Jeffrey), nest; Newport, I.O.W., 1912 (H. G. Jeffrey), nest; *C. garei*, 1 ♂, Hockley, Essex, 25.v.03 (F. W. Frohawk); *D. gallinulae*, 1 ♂, 12 ♀, Kirkwall, Orkney, 10.v.06 (J. Waterston), nest; all Rothschild Coll.; Kirkwall, Orkney, 8.vi.06 (J. Waterston), nest; 1 ♀, Lochgelly, 25.vi.09 (J. Brown); 3 ♂, 5 ♀, Arniston, Midlothian, 28.v.09 (A. Bennett), nest; all B.M. 1914.517.

FRINGILLIDAE

Coccothraustes coccothraustes (L.) (Hawfinch)

D. gallinulae, 1 ♂, 1 ♀, Eaton, nr. Chester, 5.v.01 (R. Newstead), nest; Eaton, nr. Chester, 9.v.01 (R. Newstead), nest; all Rothschild Coll.

* Name of host as in Witherby and not necessarily as on slides. Thus *Turdus musicus* becomes *Turdus ericetorum* since Waterston's publications make it clear that the Song-Thrush is the host from which he obtained the specimens in question. Certain specimens from *Corvus corone* are merely marked 'Carrion-Crow'.

† With regard to material in the British Museum, the registered number is appended in all cases unless the material referred to pertains to the Rothschild Collection (1923. 615). It must be explained that after Charles Rothschild's death in 1923 material continued to flow in to Karl Jordan, which he worked out and then incorporated in the Rothschild Collection. Although technically British Museum material, the author has made no attempt to separate it from the rest, since she feels that the date is sufficient indication of the fact that it was incorporated after the Rothschild Collection passed into the absolute control of the Trustees.

‡ When it is known for certain if specimens were collected from the body or nest of the host this information is added—whether or not it is present on the slides or tubes.

TABLE 9—(cont.)

Chloris chloris (L.) (Greenfinch)

C. gallinae, 1 ♂, 1 ♀, Colinton, Midlothian, 11.v.06 (J. Waterston), nest; *D. gallinulae*, 1 ♀, Lothianburn, 26.v.06 (?); 1 ♂, 1 ♀, Arniston, Midlothian, 28.v.09 (A. Bennett), nest; Arniston, Midlothian, 8.vi.09 (A. Bennett), nest; all B.M. 1914.517; 2 ♀, Abbey St. Bathans, Berwickshire, 14.v.07 (J. Waterston), nest; 3 ♀, Tresco, Isles of Scilly, 12.vi.07 (F. J. Cox), nest; all Rothschild Coll.

Carduelis carduelis (L.) (Goldfinch)

C. gallinae, < ♂, < ♀, Redland, Bristol, 1917 (P. Stonelake); *C. garei*, 2 ♂, 2 ♀, Fancott, nr. Luton, i.44 (R. B. Laurence), nest; all Rothschild Coll. (B.M.).

Carduelis cannabina (L.) (Linnet)

C. garei, < ♂, < ♀, Newport, I.O.W., vi.10 (H. G. Jeffrey), nest; Rothschild Coll. (B.M.).

Fringilla coelebs L. (Chaffinch)

C. gallinae, 1 ♂, Ross-shire, 16.iii.34 (W. H. Pollen), body; Rothschild Coll.; 2 ♀, Arniston, Midlothian, vi.09 (A. Bennett), nest; 3 ♀, Loudoun, Ayrshire, summer, 1909 (? collector); *D. gallinulae*, 8 ♂, 10 ♀, Inchtute, Perthshire, vii.06 (J. H. McNair), nest; Inchtute, Perthshire, viii.06 (J. H. McNair), nest; 1 ♂, Lahill, Largo, 29.x.12 (L. J. Rintoul, E. V. Baxter), body; all B.M. 1914.517; 8 ♂, 3 ♀, Lesmahagow, Lanarkshire, 31.vi.06 (J. Clark, per Watkins and Doncaster), nest; Rothschild Coll.; 2 ♂, 9 ♀, Loudoun, Ayrshire, vi.09 (J. Gloag), nest; B.M. 1914.517.

Emberiza citrinella L. (Yellow Hammer)

C. gallinae, 1 ♀, Nethercraigs, nr. Paisley, 4.v.09 (J. Waterston), nest; B.M. 1914.517; < ♀, Tring, Herts., 19.vii.04 (N.C.R.), nest; Rothschild Coll. (B.M.); *D. gallinulae*, 1 ♂, 3 ♀, Rilla Mill, Cornwall, vi.05 (K. Jordan), nest; Rothschild Coll. (B.M.).

Emberiza calandra L. (Corn Bunting)

C. garei, 1 ♀, Todhead, Kinneff, Kincardineshire, 16.vi.09 (J. Waterston), body; B.M. 1914.517.

Emberiza schoeniclus (L.) (Reed Bunting)

C. garei, 6 ♂, 3 ♀, Tring, Herts., vii.03 (N.C.R.), nest; Tring, Herts., vi.06 (F. J. Cox), nest; *D. gallinulae*, 1 ♀, Windsor Forest, Surrey, 23.vi.28 (F. W. Frohawk); all Rothschild Coll.

PLOCEIDAE

Passer domesticus (L.) (House-Sparrow)

C. gallinae, 3 ♂, 5 ♀, Carie, Rannoch, 24.vii.08 (F. J. Cox), nest; Rothschild Coll. (B.M.); < ♂, < ♀, Mull, Argyllshire, 28.viii.12 (L. G. Esson); Rothschild Coll. (B.M.); 8 ♂, 9 ♀, Wilberlea, St. Andrews, Fife, 18.viii.08 (J. Waterston), nest; 3 ♀, Auchinblae, Kincardineshire, 27.v.09 (J. Campbell); 4 ♂, 10 ♀, Kennetpans, Clackmannan, 8–10.viii.08 (J. Waterston), nest; 1 ♂, Gorebridge, nr. Dalkeith, 17.vii.06 (J. Waterston), nest; 8 ♂, < ♀, Colinton, Midlothian, 7.v.06 (J. Waterston), nest; Colinton, Midlothian, 11.v.06 (J. Waterston), nest; 2 ♂, 6 ♀, Dunlaverock, Coldingham, viii.09 (J. F. Cormack); Dunlaverock, Coldingham, 7.ix.09 (J. F. Cormack); Dunlaverock, Coldingham, ix.09 (J. F. Cormack); 1 ♂, 1 ♀, Dunlaverock, Coldingham, 2.viii.10 (J. F. Cormack), nest; < ♂, < ♀, Coldingham, Berwickshire, 25.ix.08 (J. F. Cormack), nest; Coldingham, Berwickshire, viii.09 (J. F. Cormack), nest; all B.M. 1914.517; 1 ♀, Armitage, Staffordshire, x.31 (L. C. E. Stott); 4 ♂, 1 ♀, Penarth, Glamorgan, 20.ix.28 (H. M. Hallett); 2 ♂, 3 ♀, Whipnade, Bedfordshire, nest; < ♂, < ♀, Tring, Herts., 1901 (N.C.R.), nest; Tring, Herts., vi.06 (K. Jordan), nest; Tring, Herts., ix.10 (K. Jordan), nest; < ♂, < ♀, London, xi.09 (N.C.R.), nest; all Rothschild Coll.; 2 ♂, 5 ♀, Woking, Surrey; B.M. 1910.266; 2 ♀, Pylewell Park, Lymington, Hants, 1906 (R. Newstead); < ♂, < ♀, Newport, I.O.W., v.10 (H. G. Jeffrey), nest; Newport, I.O.W., 1912 (H. G. Jeffrey), nest; all Rothschild Coll.; *D. gallinulae*, 1 ♂, Arniston, Midlothian, 28.v.09 (A. Bennett); B.M. 1914.517; 4 ♂, 2 ♀, Longwood, Southwick, Sunderland, 25.vi.10 (F. Palin); 3 ♂, 2 ♀, Park Mill, Gower Peninsula, Glamorgan, 23.v.19 (F. J. Cox), nest; all Rothschild Coll.

ALAUDIDAE

Alauda arvensis L. (Skylark)

C. gallinae, 1 ♂, Burwick, Orkney, 11.vi.06 (J. Waterston), nest; Rothschild Coll. (B.M.); 1 ♀, Aberlady, 13.vi.06 (R. Cochrane), nest; B.M. 1914.517; *C. garei*, 11 ♂, 3 ♀, Wallasey sandhills, Liverpool, 18.vi.06 (Watkins and Doncaster); Rothschild Coll.; *D. gallinulae*, 1 ♀, Ollaberry, 8.vii.12 (J. Waterston), body; 1 ♀, East of Silverside, Ollaberry, 10.vi.10 (J. Waterston), body; 1 ♂, 6 ♀, Tankerness, nr. Kirkwall, Orkney, 8.vi.06 (J. Waterston), nest; 1 ♀, Berwick, 11.vi.06 (? collector), nest; all B.M. 1914.517.

TABLE 9—(cont.)

MOTACILLIDAE

Anthus pratensis (L.) (Meadow-Pipit)

C. gallinae, 1 ♀, Cowdenbeath, Fifeshire, 10.vi.07 (J. Waterston), nest; B.M. 1914.517; *C. garei*, 1 ♀, Lochhead, Lochgelly, 21.x.09 (J. Brown), body; B.M. 1914.517; < ♂, < ♀, Newport, I.O.W., ix.10 (H. G. Jeffrey), nest; 1 ♂, Foulness Island, 28.v.34 (W. H. Pollen), body; *D. gallinulae*, 1 ♀, Walls, Shetland, vi.06 (J. Clark), per Watkins and Doncaster), nest; 3 ♂, 7 ♀, Braid Hills, nr. Edinburgh, 2.vi.06 (J. Waterston), nest; 1 ♀, Lesmahagow, Lanarkshire, 22.vii.06 (J. Clark, per Watkins and Doncaster), nest; all Rothschild Coll.

Anthus spinoletta (L.) (Rock-Pipit)

C. gallinae, 1 ♀, Ollaberry, Shetland, 18.x.10 (J. Waterston), body; *D. gallinulae*, 1 ♂, 1 ♀, nr. Haylor, Ronas Voe, Cumberland, 13.vii.12, nest; all B.M. 1914.517.

Motacilla alba yarrelli Gould (Pied Wagtail)

C. gallinae, 5 ♂, 6 ♀. Kennetpans, Clackmannan, 6.viii.08 (J. Waterston), nest; 3 ♂, 8 ♀, Arniston, Midlothian, 8.vi.09 (A. Bennett), nest; all B.M. 1914.517; 2 ♂, Westfield, Sussex, 2.viii.07 (W. R. Butterfield); *C. garei*, 3 ♂, < ♀, Tring, Herts., 1902 (N.C.R.), nest; Tring, Herts., vii.03 (N.C.R.), nest; all Rothschild Coll.; *D. gallinulae*, 2 ♂, 7 ♀, Hillend, Fife, 26.v.06 (J. Waterston), nest; 5 ♀, nr. Loganlea Waterfall, 25.v.07 (R. Cochrane), nest; 1 ♂, Arniston, Midlothian, 28.vi.09 (A. Bennett), nest; all B.M. 1914.517; 10 ♂, 5 ♀, Lesmahagow, Lanarkshire, 20.vi.06 (J. Clark, per Watkins and Doncaster), nest; 1 ♂, Ross-shire, 20.iii.34 (W. H. Pollen), body; all Rothschild Coll.

Motacilla cinerea cinerea Tunst. (Grey Wagtail)

D. gallinulae, 1 ♂, Arniston, Midlothian, 29.vi.09 (J. Waterston), nest; B.M. 1914.517; 2 ♀, Coalburn, Lanarkshire, vi.06 (J. Clark), nest; Rothschild Coll. (B.M.).

CERTHIIDAE

Certhia familiaris (L.) (Tree-Creeper)

D. gallinulae, 1 ♀, Howick, Northumberland, 1.xi.34 (W. H. Pollen), body; Rothschild Coll. (B.M.).

SITTIDAE

Sitta europaea L. (Nuthatch)

C. gallinae, 6 ♂, 6 ♀, Hastings, Sussex, 1909 (W. R. Butterfield); Rothschild Coll. (B.M.).

PARIDAE

Parus major L. (Great Tit)

C. gallinae, < ♂, < ♀, Arniston, Midlothian, 4.vi.09 (A. Bennett), nest; B.M. 1914.517; 1 ♀, Ashbourne, Derbyshire (F. C. R. Jourdain); 2 ♂, 4 ♀, Kingsland, Herefordshire, 19.v. (? year) (R. Williams); < ♂, < ♀, Tring, Herts., ix.21 (F. J. Cox), nest; 3 ♂, < ♀, Chingford, London, 1910 (C. Nicholson); 1 ♀, Surrey, 13.vi.09 (H. Russell); < ♂, < ♀, Shere, Guildford, 13.vi.09; < ♂, < ♀, Sussex, 22.iv.08 (W. R. Butterfield); all Rothschild Coll.; 1 ♀, Perch and Nagshead, Gloucester, 28/29.vii.45 (received from Com. Inst. Ent. per Dr. K. Jordan), nest; B.M. 1914.517; < ♂, < ♀, Wembdon, nr. Bridgwater, 1902 (G. Gare); Wembdon, nr. Bridgwater, no date (G. Gare); 2 ♂, Ross-shire, 20.iii.34 (W. H. Pollen), body; < ♂, < ♀, Bere Regis, Dorset, 15.vii.19 (H. Russell); < ♂, < ♀, Dorset, vi.14 (H. Russell); all Rothschild Coll.; *D. gallinulae*, 2 ♂, 2 ♀, Cowdenbeath, 10.vi.07 (J. Waterston), nest; 1 ♂, 1 ♀, Aberdour, Fife, v.07 (J. Waterston); 1 ♂, Arniston, Midlothian, 4.vi.09 (A. Bennett), nest; all B.M. 1914.517.

Parus coeruleus L. (Blue-Tit)

C. gallinae, 8 ♂, < ♀, Kennetpans, Clackmannan, 8-10.viii.08 (J. Waterston), nest; < ♂, < ♀, Arniston, Midlothian, vi.09 (A. Bennett), nest; all B.M. 1914.517; < ♂, < ♀, Rosehill, Cheadle, Staffordshire, xii.13 (J. R. B. Masefield); < ♂, < ♀, Cardiff, 12.vi.33 (H. M. Hallett), nest; < ♂, < ♀, Ashton, Oundle, ix.02 (N.C.R.), nest; Ashton, Oundle, vi.10 (J. Stuart), nest; 1 ♀, Hockley, Essex, 18.v.03 (F. W. Frohawk); < ♂, < ♀, London, xi.09 (N.C.R.), nest; 1 ♂, 3 ♀, Chiswick, ii.01 (A. Sich); 8 ♂, 6 ♀, Hastings, Sussex, 1909 (W. R. Butterfield); < ♂, < ♀, Reading, Berks., 9.vi.39 (B. T. Parsons), nest; 1 ♂, 1 ♀, Rilla Mill, Cornwall, vi.05 (K. Jordan), nest; *D. gallinulae*, 1 ♀, Ross-shire, 20.iii.34 (W. H. Pollen), body; 3 ♂, 2 ♀, Crickleigh, Gloucester, 24.iv.04 (R. Newstead); all Rothschild Coll.

Aegithalos caudatus (L.) (Long-tailed Tit)

D. gallinulae, 5 ♂, Essex, 1910 (H. Russell); Rothschild Coll.

Panurus biarmicus (L.) (Bearded Tit)

C. garei, < ♂, < ♀, Hickling Broad, Norfolk, 8.v.16 (H. Russell), nest; 6 ♂, 4 ♀, Horeton Broad, Cromer, vii.1896 (F. H. Barclay), both Rothschild Coll.

TABLE 9—(cont.)

MUSCICAPIDAE

Muscicapa striata (Pall.) (Spotted Flycatcher)

C. gallinae, 1 ♀, Kinneff, Kincardineshire, 15.vi.09 (J. F. Cormack), nest; 2 ♀, Gorebridge, Dalkeith, 12.vii.06 (? collector), nest; 9 ♀, Arniston, Midlothian, 3.viii.09 (A. Bennett); *D. gallinulae*, 5 ♀, Kinneff, Kincardineshire, 5.vi.09 (J. F. Cormack), nest; 3 ♀, Gorebridge, 12.vii.06 (J. Waterston), nest; all B.M. 1914.517; 1 ♀, Lesmahagow, Lanarkshire, 5.viii.06 (J. Clark, per Watkins and Doncaster), nest; 1 ♂, 1 ♀, Tring, Herts., vii.19 (K. Jordan), nest; 1 ♂, 1 ♀, Newport, I.O.W., ix.1900 (H. G. Jeffrey), nest; all Rothschild Coll.

SYLVIIDAE

Phylloscopus collybita (Vieill.) (Chiff-Chaff)

C. gallinae, 2 ♂, 1 ♀, Devon, vi.35 (G. M. Spooner), nest; *D. gallinulae*, 8 ♂, < ♀, Lesmahagow, Lanarkshire, vii.06 (J. Clark, per Watkins and Doncaster), nest; 3 ♀, Reigate, Surrey, 12.vi.01 (C. Reeves); all Rothschild Coll.

Phylloscopus trochilus (L.) (Willow-Warbler)

D. gallinulae, 2 ♂, 3 ♀, Glencorse Pond, 3.vii.07 (R. Cochrane), nest; 1 ♂, 3 ♀, Arniston, Midlothian, 3-4.vi.09 (A. Bennett), nest; all B.M. 1914.517; < ♂, < ♀, Tring, Herts., vi.28 (K. Jordan), nest; < ♂, < ♀, Tring, Herts., vii.28 (K. Jordan), nest; all Rothschild Coll.

Phylloscopus sibilatrix (Bechst.) (Wood-Warbler)

D. gallinulae, < ♂, < ♀, Arniston, Midlothian, vi.09 (A. Bennett), nest; B.M. 1914.517.

Acrocephalus schoenobaenus (L.) (Sedge-Warbler)

D. gallinulae, 2 ♂, Tring, Herts., v.34 (L. Goodson), nest; Rothschild Coll.

Sylvia borin (Bodd.) (Garden Warbler)

D. gallinulae, 3 ♂, 4 ♀, Arniston, Midlothian, 25.vi.09 (A. Bennett), nest; B.M. 1914.517.

Sylvia communis Lath. (Whitethroat)

D. gallinulae, 1 ♀, Skokholm Bird Observatory (R. M. Lockley), body; Rothschild Coll.

Sylvia curruca (L.) (Lesser Whitethroat)

D. gallinulae, 9 ♂, 10 ♀, Tansor Wold, Oundle, v.06 (F. J. Cox), nest; Rothschild Coll.

TURDIDAE

Turdus viscivorus L. (Mistle Thrush)

C. gallinae, 1 ♂, 1 ♀, Colinton, Midlothian, 24.v.06 (J. Waterston); *D. gallinulae*, 1 ♂, 6 ♀,

Hillend, Fife, 25.v.08 (R. Cochrane), nest; 2 ♀, Loganlea Waterfall, 25.v.07 (R. Cochrane), nest; all B.M. 1914.517.

Turdus ericetorum Turton (Song-Thrush)

C. gallinae, 1 ♂, Colinton, Midlothian, 7.v.06 (J. Waterston), nest; B.M. 1914.517; 1 ♀, Nethercraigs, Paisley, 4.v.09 (J. Waterston), joint nest with *T. merula*; B.M. 1914.517; < ♂, < ♀, Loch Ranza, Arran Isle, N.B., vi.27 (F. J. Cox), nests; 2 ♀, Tring, Herts., 10.xi.14 (E. Hartert); all Rothschild Coll.; *D. gallinulae*, 2 ♂, Kinneff, Kincardineshire, 14.vi.09 (J. Waterston), body; 1 ♂, 1 ♀, Colinton, Midlothian, 7.v.06 (J. Waterston), nest; 1 ♂, 3 ♀, Nethercraigs, Paisley, 4.v.09, joint nest with *T. merula*; all B.M. 1914.517; 1 ♂, 1 ♀, Crickeigh, Gloucester, 20.iv.06; Rothschild Coll.

Turdus merula L. (Blackbird)

C. gallinae, 1 ♀, St. Margaret's Hope, South Ronaldshay, Orkney, vi.06 (J. Waterston), nest; B.M. 1914.517; 2 ♂, 4 ♀, Carie, Rannoch, 23.vii.08 (F. J. Cox), nest; Rothschild Coll.; 1 ♀, Woodburn House, nr. Dalkeith, 12.v.08 nest; 1 ♂, 3 ♀, Colinton, Midlothian, 15.iv.07 (J. Waterston), nests; Colinton, Midlothian, 26.vii.09 (J. Waterston), body; 1 ♀, Nethercraigs, Paisley, 4.v.09 (J. Waterston), joint nest with *T. ericetorum*; all B.M. 1914.517; 1 ♀, Armitage, Staffordshire, i.33 (L. C. E. Stott), nest; 5 ♀, Tring, Herts., vii.1900 (N.C.R.), nest; Tring, Herts., 15.vii.11 (H. Mugford); 4 ♂, 7 ♀, Reigate, Surrey, 12.vi.18 (C. E. Stott); < ♂, < ♀, Newport, I.O.W., v.10 (H. G. Jeffrey), nest; Newport, I.O.W., ix.10 (H. G. Jeffrey), nest; < ♀, St. Mary's, Scilly Isles, 11.vi.07 (F. J. Cox), nest; all Rothschild Coll.; *C. garei*, 1 ♂, Park House, Crathorne, Yarm-on-Tees, Yorks. (? collector), nest; B.M. 1920.166 (presented by S. Hirst); 1 ♂, Newport, I.O.W., iv.10 (H. G. Jeffrey); *D. gallinulae*, 3 ♂, 3 ♀, Kilonan, Arran Is., Ireland, vii.06 (M. Mullin, per Watkins and Doncaster); 1 ♂, 1 ♀, Hillend, Fife, 18.v.06 (J. Waterston), nest; all Rothschild Coll.; 4 ♂, < ♀, Flotterstone, Fifeshire, 13.v.06 (J. Waterston), nest; 4 ♂, 5 ♀, Aberdeen, Fife, 20.iv.07 (J. Waterston), nest; 1 ♀, Burntisland, 8.x.09 (Rettie); 2 ♂, 1 ♀, St. Margaret's, nr. Queensferry, 9.vi.09 (W. H. Elder), nest; all B.M. 1914.517; 3 ♂, 8 ♀, Colinton, nr. Edinburgh, 24.v.06 (J. Waterston); Colinton, nr. Edinburgh, 25.v.06 (J. Waterston); all Rothschild Coll.; 4 ♂, 2 ♀, Arniston, Midlothian, 3.vi.09 (A. Bennett), nest; Nethercraigs, Paisley, 4.v.09, joint nest with *T. musicus* (= *ericetorum*); all B.M. 1914.517; 1 ♂, 1 ♀, Tring, Herts.,

TABLE 9—(cont.)

- 15.vii.11 (H. Mugford); 1 ♂, Newport, I.O.W., iv.10 (H. G. Jeffrey), nest; all Rothschild Coll.
- Oenanthe oenanthe* (L.) (Wheatear)
D. gallinulae, 1 ♀, Gluss Voe, west side, Ollaberry, 28.iv.13 (J. Waterston), body; B.M. 1914.517.
- Saxicola torquata* (L.) (Stonechat)
D. gallinulae, < ♂, < ♀, Loudoun Estate, Ayrshire, 12.vi.09 (J. Gloag), nest; B.M. 1914.517.
- Phoenicurus phoenicurus* (L.) (Redstart)
C. gallinae, 1 ♀, Gorebridge, nr. Dalkeith (? collector), nest; < ♂, < ♀, Arniston, Midlothian, 25.vi.09 (? collector), nest; *D. gallinulae*, 9 ♂, < ♀, Arniston, Midlothian, i.vii.06 (A. Bennett), nest; Arniston, Midlothian, 28.v.09 (A. Bennett), nest; all B.M. 1914.517.
- Erithacus rubecula* (L.) (Robin)
C. gallinae, 1 ♂, Auchinblae, Kincardineshire, 17.iv.09 (J. Duffus), nest; *D. gallinulae*, 1 ♂, 1 ♀, Auchinblae, Kincardineshire, 17.iv.09 (J. Duffus), nest; all B.M. 1914.517; 3 ♂, 3 ♀, Hillend, Fife, 29.v.06 (? collector), nest; 3 ♀, Flotterstone, Fife, 29.v.06; 5 ♂, 2 ♀, Colinton, Midlothian, vi.06 (J. Waterston), nest; all B.M. 1914.517; 2 ♂, 8 ♀, Carie, Rannoch, N.B., vii.08 (F. J. Cox), nest; 1 ♀, Banbury, 4.xii.34 (W. H. Pollen), body; 2 ♂, < ♀, Loch Ranza, Arran Isle, vii.27 (F. J. Cox), nests; < ♂, < ♀, nr. Park Mill, Gower Peninsula, Glamorgan, v.19 (F. J. Cox), nest; < ♂, < ♀, Tring, Herts., 7.viii.01 (N.C.R.), nest; Tring, Herts., 3.ix.01 (N.C.R.), nest; Tring, Herts., 17.ix.01 (N.C.R.), nest; Tring, Herts., 5.x.01 (N.C.R.), nest; 1 ♂, 2 ♀, Newport, I.O.W., ix.10 (H. G. Jeffrey), nest; Newport, I.O.W., 1912 (H. G. Jeffrey), nest; all Rothschild Coll.
- PRUNELLIDAE
- Prunella modularis* (L.) (Hedge-Sparrow)
C. gallinae, 1 ♀, Quixewood, Berwickshire, 14.v.07 (J. Waterston), nest; 5 ♀, Elveden, Suffolk, 14.viii.07 (F. J. Cox), nest; 1 ♀, Tring, Herts., 1901 (N.C.R.), nest; 4 ♂, 1 ♀, Crickleigh, Gloucester, 21.iv.06 (R. Newstead); 1 ♀, Northampton, 1.xii.34 (W. H. Pollen), body; all Rothschild Coll.; *C. garei*, 1 ♂, Newport, I.O.W., v.10 (H. G. Jeffrey); Rothschild Coll.; *D. gallinulae*, 4 ♂, 9 ♀, Hillend, Fife, 26.v.06 (J. Waterston), nest; 2 ♂, 3 ♀, Edinburgh, 12.v.08 (J. Waterston), nest; 5 ♂, 10 ♀, Colinton, Midlothian, 13.v.06 (J. Waterston); Colinton, Midlothian, 24.v.06 (J. Waterston); Colinton, Midlothian, 19.v.09 (J. Waterston); Colinton, Midlothian, 31.vi.09 (J. Waterston), body; all B.M. 1914.517; 1 ♀, Dumbarton, Scotland, 21.ix.34 (W. H. Pollen), body; Rothschild Coll.; 3 ♂, 4 ♀, Arniston, Midlothian, vi.09 (A. Bennett), nest; B.M. 1914.517; < ♂, < ♀, Talacre, nr. Prestatyn, 16.v.03 (R. Newstead); 1 ♀, Newport, I.O.W., v.10 (H. G. Jeffrey), nest; all Rothschild Coll.
- TROGLODYTIDAE
- Troglodytes troglodytes* (L.) (Wren)
C. gallinae, 1 ♀, Lamba, Shetland, 25.ix.12 (J. Waterston), nest; B.M. 1914.517; 6 ♂, 7 ♀, Ashton, Oundle, vi.06 (F. J. Cox), nest; 2 ♂, < ♀, Tring, Herts., 5.x.01 (N.C.R.), nest; *D. gallinulae*, 2 ♂, 1 ♀, St. Kilda, 1900 (W. Eagle Clarke); all Rothschild Coll.; 1 ♀, Gluss Voe, Ollaberry, 20.ix.10 (J. Waterston), body; 4 ♂, < ♀, between Hillend and Flotterstone, Fife, 29.v.06 (J. Waterston), nest; 2 ♂, 3 ♀, nr. Loganlea Waterfall, 25.v.07 (J. Waterston), nest; all B.M. 1914.517; 1 ♀, Lesmahagow, Lanarkshire, 5.viii.06 (J. Clark, per Watkins and Doncaster), nest; Rothschild Coll.; 1 ♂, Pettadale Water, nr. R. Roe, 24.iv.12 (J. Waterston), body; B.M. 1914.517; 1 ♂, 1 ♀, Cardiff, 14.vi.31 (H. M. Hallett, A. H. Salmon); 2 ♀, Tring, Herts., vi.01 (N.C.R.), nest; all Rothschild Coll.
- CINCLIDAE
- Cinclus cinclus* (L.) (Dipper)
C. gallinae, 1 ♀, Auchinblae, Kincardineshire, 14.iv.09 (L. Duffus), nest; 1 ♂, Abbey St. Bathans, Berwickshire, 26.v.07; all B.M. 1914.517; 1 ♂, 1 ♀, Rothbury, Sunderland, vii.06 (per Watkins and Doncaster), Rothschild Coll.; *D. gallinulae*, 9 ♂, < ♀, Torduff Reservoir, Midlothian, 12.v.09 (J. Waterston), nest; B.M. 1914.517; 1 ♀, nr. Granthouse, 14.v.07 (J. Waterston), nest; B.M. 1914.517; 1 ♀, Nantyyfrith, nr. Minera, Flintshire, 5.v.01 (R. Newstead); Rothschild Coll.
- HIRUNDINIDAE
- Hirundo rustica* L. (Swallow)
C. gallinae, 2 ♂, 7 ♀, Dirleton, East Lothian, 2.ix.09 (J. Gardiner), nest; 3 ♂, 7 ♀, Howletburn, Galston, Ayrshire, 4.ix.10 (J. Gloag), nest; all B.M. 1914.517; 8 ♂, < ♀, Newport, I.O.W., 1912 (H. G. Jeffrey), nest; Newport, I.O.W., 1914 (H. G. Jeffrey), nest; all Rothschild Coll.
- Delichon urbica* (L.) (House-Martin)
C. gallinae, 7 ♂, 5 ♀, Mull, Argyllshire, ix.12 (L. G. Esson); Mull, Argyllshire, 7.i.13 (L. G. Esson); all Rothschild Coll.; 2 ♂, 4 ♀, Gladhouse,

TABLE 9—(cont.)

- Midlothian, 13.viii.06 (J. Waterston), nest; B.M. 1914.517; < ♂, < ♀, Dunlaverock, Berwickshire, ix.06 (J. Waterston), nest; Rothschild Coll.; 9 ♂, 10 ♀, Dunlaverock, Coldingham, 24.ix.06 (J. F. Cormack), nest; Dunlaverock, Coldingham, viii.09 (J. F. Cormack), nest; Dunlaverock, Coldingham, ix.09 (J. F. Cormack), nest; 1 ♂, 1 ♀, Dunlaverock, Coldingham, 2.viii.10 (J. F. Cormack); all B.M. 1914.517; 10 ♂, 6 ♀, Ashton, Oundle, viii.06 (F. J. Cox), nest; Rothschild Coll.
- Riparia riparia* (L.) (Sand-Martin)
C. gallinae, 5 ♂, Reigate, Surrey, ix.25 (L. C. E. Stott); Rothschild Coll.
- APODIDAE
- Apus apus* (L.) (Swift)
C. gallinae, 3 ♂, 8 ♀, Newport, I.O.W., 1913 (H. G. Jeffrey), nest; 2 ♂, 5 ♀, Wembdon, nr. Bridgwater, 3.vii.01 (G. Gare); Wembdon, nr. Bridgwater, 1902 (G. Gare); all Rothschild Coll.
- PICIDAE
- Picus viridis* L. (Green Woodpecker)
C. gallinae, 1 ♀, Northampton, 25.v.34 (W. H. Pollen), body; Rothschild Coll.
- Jynx torquilla* (L.) (Wryneck)
C. gallinae, < ♂, < ♀, Wembdon, nr. Bridgwater, 1902 (G. Gare); *C. garei*, 1 ♀, Wembdon, nr. Bridgwater, 1902 (G. Gare); all Rothschild Coll.
- STRIGIDAE
- Asio otus* (L.) (Long-eared Owl)
C. gallinae, < ♂, < ♀, Newport, I.O.W., ix.10 (H. G. Jeffrey), nest; Newport, I.O.W., 1912 (H. G. Jeffrey), nest; all Rothschild Coll.
- Tyto alba* (Scop.) (Barn-Owl)
C. gallinae, 2 ♂, 4 ♀, Ashton Wold, Oundle, vi.26 (F. J. Cox), nest; < ♂, < ♀, Tring, Herts., summer, 1919 (F. J. Cox), nest; 2 ♂, Reigate, Surrey, 10.viii.1900 (C. Reeves); 9 ♂, 10 ♀, Hastings, Sussex, 1909 (W. R. Butterfield); all Rothschild Coll.
- Strix aluco* L. (Tawny Owl)
C. gallinae, < ♂, < ♀, Arniston, Midlothian, iv.09 (A. Bennett), nest; Arniston, Midlothian, vi.09 (A. Bennett), nest; all B.M. 1914.517; 1 ♂, 1 ♀, Upton, nr. Chester, 25.v.05; 4 ♀, Tring, Herts. (M.R.), nest; 2 ♂, 7 ♀, Tring, Herts., 1936 (M.R.); 1 ♂, Northampton, 21.iv.34 (W. H. Pollen), body; all Rothschild Coll.
- Athene noctua* (Scop.) (Little Owl)
C. gallinae, 1 ♀, Northamptonshire, 22.v.34 (W. H. Pollen), body; 5 ♂, 4 ♀, Northamptonshire, 12.iv.34 (W. H. Pollen), body; all Rothschild Coll.
- FALCONIDAE
- Accipiter nisus* (L.) (Sparrow-Hawk)
C. gallinae, 1 ♂, Bradford, Yorks., viii.29 (N. H. Joy), nest; < ♂, 2 ♀, Tring, Herts., summer, 1919 (N.C.R.), nest; < ♂, < ♀, Newport, I.O.W., 1912 (H. G. Jeffrey), nest; 1 ♀, Norfolk, 18.iv.34 (W. H. Pollen), body; *D. gallinulae*, 1 ♂, Beaconsfield, Buckinghamshire, 16.vii.34 (W. H. Pollen), body; all Rothschild Coll.
- ANATIDAE
- Anas platyrhynchos* L. (Mallard)
C. garei, 2 ♂, 3 ♀, Lochgelly, Fifeshire, 25.v.09 (J. Brown), nest; B.M. 1914.517 < ♂, < ♀, Tring, Herts., vii.03 (F. J. Cox), nest; Tring, Herts., v.05 (N.C.R.), nest; all Rothschild Coll.
- Anas acuta* L. (Pintail)
C. garei, 6 ♂, 3 ♀, Orkney Islands, vi.11 (N. H. Joy), nest; Rothschild Coll.
- Aythya fuligula* (L.) (Tufted Duck)
C. garei, < ♂, < ♀, Merton, Oxford, vi. (? date) (Lord Walsingham); 1 ♀, Thetford, Norfolk, 2.vi. (? date) (per British Museum); all Rothschild Coll.
- Somateria mollissima* (L.) (Common Eider)
C. garei, 4 ♂, Orkney Islands, vi.11 (N. H. Joy), nest; Rothschild Coll.; 1 ♂, 1 ♀, Tankerness, Pomona, 8.vi.06 (J. Waterston), nest; B.M. 1914.517; 8 ♂, < ♀, Bass Rock, Firth of Forth, vii.26 (F. J. Cox), nest; Rothschild Coll.
- Melanitta nigra* (L.) (Common Scoter)
C. garei, < ♂, < ♀, Little Roe, Shetland, vii.10 (J. Waterston), nest; Rothschild Coll.
- Mergus serrator* L. (Red-breasted Merganser)
C. garei, 1 ♀, Belfast, Ireland, 2.vi.34 (W. H. Pollen), body; Rothschild Coll.
- PHALACROCORACIDAE
- Phalacrocorax aristotelis* (L.) (Shag)
C. garei, < ♂, < ♀, Lamba Island, Shetland, vii.12, nest; < ♂, < ♀, Lamba Island, Shetland, xii.13, nest; all B.M. 1914.517; < ♂, < ♀, Orkney Islands, vi.11 (N. H. Joy), nest; Rothschild Coll.

TABLE 9—(cont.)

HYDROBATIDAE

Hydrobates pelagicus (L.) (Storm-Petrel)

C. gallinae, 1 ♂, Borough of Copister, SE. end of Yell, opposite Mossbank, Shetland, 25.vii.13 (J. Waterston and Captain Jensen), nest; B.M. 1914.517.

Fulmarus glacialis (L.) (Fulmar Petrel)

C. gallinae, 1 ♀, Ross-shire, 5.i.35 (W. H. Pollen), body; Rothschild Coll.; *D. gallinulae*, 2 ♂, Uyea Island, Shetland, 24.iv.12 (J. Waterston), body; Uyea Island, Shetland, vi.12 (J. Waterston), near nest; all B.M. 1914.517.

COLUMBIDAE

Columba palumbus L. (Wood-Pigeon)

C. gallinae, 6 ♀, Berkshire, 11.iv.34 (W. H. Pollen), body; Rothschild Coll.

Columba oenas L. (Stock-Dove)

C. gallinae, 1 ♀ Colinton, Midlothian, 19.v.09 (J. Waterston), nest; Rothschild Coll.

Columba livia Gm. (Rock-Dove)

C. gallinae, < ♂, < ♀, Little Roe, Yell Sound, Shetland, 17.vii.11 (J. Waterston), nest; 1 ♀, Caves in cliffs, Todhead, Kinneff, 15.vi.09 (J. Waterston), nest; all B.M. 1914.517; 1 ♀, Belfast, Ireland, 24.v.35 (W. H. Pollen), body; *C. garei*, 4 ♂, < ♀, Little Roe, Shetland, 17.vii.11 (J. Waterston), nests; *D. gallinulae*, 4 ♂, 5 ♀, in a cave NE. end of Little Roe, Shetland, 17.vii.11 (J. Waterston), nest; all Rothschild Coll.

SCOLOPACIDAE

Scolopax rusticola L. (Woodcock)

D. gallinulae, 8 ♂, < ♀, Aberdour, Fifeshire, 25.v.07 (J. Waterston), nest; B.M. 1914.517.

Capella gallinago (L.) (Snipe)

C. garei, 1 ♀, Northmavine, Shetland (R. H. McNair); 5 ♀, Tankerness, Orkney, 8.vi.06 (J. Waterston), nest; < ♂, < ♀, Lochgelly, Fifeshire, 25.v.09 (J. Brown), nest; all B.M. 1914.517.

Calidris alpina (L.) (Dunlin)

C. garei, < ♂, < ♀, Tinga Skerry, Yell Sound, Shetland, 11.vii.12 (J. Waterston), nest; B.M. 1914.517.

Tringa totanus (L.) (Redshank)

C. garei, 1 ♂, 2 ♀, Lochgelly, Fifeshire, 25.v.09 (J. Brown), nest; B.M. 1914.517.

Charadrius hiaticula L. (Ringed Plover)

C. garei, 1 ♀, Ollaberry, Shetland, 22.ix.10 (J. Waterston), body; 1 ♀, Aberlady, nr. Edinburgh, 22.v.09 (J. F. Cormack), nest; all B.M. 1914.517.

Vanellus vanellus (L.) (Lapwing)

C. garei, 2 ♂, Tents Moor, Fifeshire, 12.vi.09 (J. F. Cormack), nest; 4 ♂, 5 ♀, Lochhead, Lochgelly, Fifeshire, 25.iii.09 (J. Brown), nest; 5 ♂, 3 ♀, Aberlady, nr. Edinburgh, 22.v.09 (J. F. Cormack), nests; Aberlady, nr. Edinburgh, 10.v.10 (J. F. Cormack), nest; all B.M. 1914.517.

LARIDAE

Larus ridibundus L. (Black-headed Gull)

C. garei, 1 ♀, Orkney Islands, vi.11 (N. H. Joy), nest; Rothschild Coll.

Larus canus L. (Common Gull)

C. garei, < ♂, < ♀, Little Roe, Shetland, v.11 (J. Waterston), nest; B.M. 1914.517.

Larus fuscus L. (Lesser Black-backed Gull)

C. garei, 3 ♂, 7 ♀, Walls, Shetland, viii.06 (per Watkins and Doncaster), nest; Rothschild Coll.

STERCORARIIDAE

Stercorarius parasiticus (L.) (Arctic Skua)

C. garei, < ♂, < ♀, Hascussay, Shetland, 7.vii.11 (M. Meade-Waldo); Rothschild Coll.

Crex crex (L.) (Corn-Crake)

C. garei, < ♂, < ♀, found by taxidermist in Nat. Hist. Mus., London; body; Rothschild Coll.

RALLIDAE

Gallinula chloropus (L.) (Moorhen)

C. gallinae, 1 ♂, 5 ♀, Ashton, Oundle, v.06 (F. J. Cox), nest; Rothschild Coll.; *C. garei*, < ♂, 9 ♀, Arniston, Midlothian, 26.vii.06 (A. Bennett), nest; 1 ♂, 3 ♀, on the Eye, Grant-house, Berwickshire, 14.v.07, nest; all B.M. 1914.517; 2 ♀, Ashton, Oundle, vi.06 (F. J. Cox), nest; 2 ♂, 5 ♀, Tring, Herts., vii.02 (N.C.R.), nest; all Rothschild Coll.; *D. gallinulae*, 5 ♀, Glencorse Pond, 29.v.06 (J. Waterston), nest; 1 ♂, 4 ♀, Arniston, Midlothian, 29.vi.09 (J. Waterston), nest; all B.M. 1914.517; 2 ♂, Ashton, Oundle, v.06 (F. J. Cox), nest; Rothschild Coll.

TETRAONIDAE

Lagopus scoticus (Lath.) (Red Grouse)

C. garei, 2 ♂, 6 ♀, Tankerness, Orkney, 8.vi.06 (J. Waterston), nest; B.M. 1914.517; 1 ♂, 1 ♀,

TABLE 9—(cont.)

Perth, Scotland, 2.vii.07 (A. E. Shipley); *D. gallinulae*, 1 ♀, Tankerness, nr. Stromness, Kirkwall, Orkney, 4.vi.06 (J. Waterston), nest; 1 ♂, (A. E. Shipley); all Rothschild Coll.

PHASIANIDAE

Phasianus colchicus L. (Pheasant)

C. gallinae, 1 ♂, 1 ♀, Cowdenbeath, Fifeshire, 10.vi.07 (J. Waterston), nest; B.M. 1914.517; 3 ♀, Windsor Forest, v.30 (H. Donisthorpe), nest; Rothschild Coll.; *C. garei*, 2 ♂, 5 ♀, Lochgelly, Fifeshire, 25.v.09 (J. Brown), nest; 1 ♀, Arniston, Midlothian, 28.v.09 (A. Bennett), nest; 1 ♂, 1 ♀, Aberlady, nr. Edinburgh, 22.v.09 (J. F. Cormack), nest; all B.M. 1914.517; 1 ♀, Tring, Herts., summer, 1919 (F. J. Cox), nest; 1 ♂, 1 ♀, Windsor Forest, v.30 (H. Donisthorpe), nest; *D. gallinulae*, 1 ♀, Ross-shire, 4.i.35 (W. H. Pollen), body; 1 ♀, Aberdour, Fifeshire, 25.v.07 (J. Waterston), nest; all Rothschild Coll.

Perdix perdix (L.) (Common Partridge)

C. garei, 1 ♀, banks of Bervie, Arbutnot, Kincardineshire, 14.vi.09, nest; B.M. 1914.517;

< ♂, < ♀, Ashton Wold, Oundle, vi.19 (J. Stuart), nest; 9 ♂, < ♀, Newport, I.O.W., ix.1900 (H. G. Jeffrey); all Rothschild Coll.

Alectoris rufa (L.) (Red-legged Partridge)

C. garei, < ♂, < ♀, Tring, Herts., summer, 1911 (F. J. Cox), nest; Rothschild Coll.

DOMESTIC POULTRY

Gallus domesticus L. (Fowl)

C. gallinae, 1 ♂, 3 ♀, Kinneff, Kincardineshire, 14.vi.09 (J. R. Frazer), nest; 2 ♂, 6 ♀, Dirleton, East Lothian, 2.ix.09 (J. Gardiner), nest; 1 ♀, Colinton, Midlothian, 24.v.06 (J. Waterston), nest; 5 ♂, 9 ♀, Biggar, Lanarkshire, 10.ix.09, nest; all B.M. 1914.517; 1 ♀, Buckingham, 29.v.01 (L. W. Rothschild); < ♂, 2 ♀, Tring, Herts., 7.xii.1899 (N.C.R.), nest; Tring, Herts., 1901 (N.C.R.), nest; all Rothschild Coll.; 6 ♂, < ♀, Woking, Surrey; B.M. 1910.266 (Edward Saunders Coll.); 4 ♀, Richmond, viii.36; < ♂, < ♀, Newport, I.O.W., 1912; all Rothschild Coll.

from one bird), *C. garei* (1), *D. g. gallinulae* (several), *C. farreni* (2), *C. rusticus* (1), *C. columbae* (1), and *M. sciurorum* (1). No other bird in Britain has such an impressive list of 'stragglers' except the Puffin (*Fratercula arctica*) which nests in burrows under conditions particularly favouring straggling.

A bird, on the other hand, which may possibly be unattractive to fleas is the Swift (*Apus apus*). It is classified among Nordberg's hole or half-hole nesters, and has a fairly high nidicolous fauna. Furthermore the sites chosen, the tendency to return year after year to the old nest and to breed in colonies, and also the close texture of the nest, should all contribute—as indeed they do in the case of the House-Martin—to a rich flea-fauna, both with regard to the number of species and to the size of the flea population. The very reverse is true, since the only fleas found in the nest of the Swift are *C. gallinae* and *C. fringillae*, which are no doubt acquired from the old Sparrows' nests of which the Swift often makes use if they are situated in suitable holes or cracks (Witherby, 1938).

Another curious fact is the absence of *C. garei* from the nests of the Herring-Gull. This flea has been recorded from *L. ridibundus*, *L. canus*, *L. marinus*, and *L. fuscus* in Britain, but the only record of *C. garei* from the Herring-Gull (Waterston, 1910) has proved on re-examination of the specimens to refer to atypical females, probably of *C. borealis* (Rothschild, 1948). Owing to the search for *C. vagabunda* we have a number of negative records of the Herring-Gull's nest—negative as far as *C. garei* is concerned. There are sixteen such records from R. M. Allan and a further nine (at least) from E. O'Mahony. Is there some unknown factor about the Herring-Gull or its nest which suits *C. vagabunda* but not *C. garei*?

Swans, also, seem unattractive to bird-fleas, and although their nests are accessible

and frequently searched no fleas have been recorded from the genus *Cygnus* in any part of the world. The same applies to the Kingfishers (*Alcedo*).

Seasonal variation in numbers. The monthly records of fleas found on the bodies of British birds by the three chief collectors are set out in Table 10. Fleas are seen to occur in every month of the year, but the lack of negative records and the smallness of the numbers make it impossible to compile seasonal frequencies. Colonel Meinertzhagen has informed me that most of his collecting was done in the months of April, August, and October. Thus, for example, out of 131 specimens of *Sturnus v. zetlandicus*, 111 were shot in August. The record of ten infested birds in March (Table 10) is nevertheless interesting, since nesting of the species concerned has scarcely commenced, although some individuals may be visiting old sites. It is to be expected that the peak of infestation occurs in the breeding-season. Three additional midwinter records not included in Table 10 are available, *C. gallinae* from the Siskin (*Carduelis spinus*) in February (Dale, 1878), the same species—a heavy infestation—from the Black Redstart (*Phoenicurus ochrurus gibraltariensis*) in November (Williamson, 1939), and a specimen of *C. garei* from the Blackbird also in November (Turk, 1946). These winter records, although few in number, do prove conclusively that fleas may be present on the bodies of birds all the year round.

Fleas on passage migrants. Two of Colonel Meinertzhagen's records come from migrant birds—a male *C. gallinae* from *Sylvia b. borin* and a female *C. gallinae* from *Sylvia n. nisoria* shot in the Shetlands in August, 1939. Since Colonel Meinertzhagen was at the time collecting specimens for the purpose of studying the British races of birds, he avoided as far as possible shooting migrants, and the total is therefore deceptive. Mr. O'Mahony has kindly sent me two unpublished records of a male and a female *D. g. gallinulae* collected from two migrant Wheatears (*Oenanthe oenanthe*) from Fair Isle in August 1950. Two separate records of *D. g. gallinulae* (without dates) from the body of *Sylvia communis* taken by R. M. Lockley at Skokholm Bird Observatory were from migrants. The Black Redstart referred to above was one of a party of migrants which reached the Isle of Man on 12 November. There is no reason to suppose that migrant birds are free from fleas, and in fact the contrary is indicated.

Time spent on the host's body. It is a matter of interest that *D. g. gallinulae* is more closely associated with the body of the host than either of the other two common bird-fleas (Table 4) and probably spends relatively less time in the nest. This may be one of the reasons why it has succeeded in spreading from the New World to the Old. In 1911 K. Jordan and C. Rothschild found several larvae of *D. g. gallinulae* feeding on the epidermis under the wings of a dead nestling Blackbird, another piece of evidence possibly suggesting a closer association with the host itself than is usual with bird-fleas. Living nestlings are rarely examined for flea larvae. Another matter concerning this species which is worth investigating is the question of its breeding-season. It was first shown by Bacot (1914) and later confirmed by Ioff (1939) that *C. gallinae*, unlike many mammal fleas, has a fixed breeding-season, which coincides with the spring and summer nesting-season of its hosts, and which cannot be altered under laboratory conditions by a rise or fall in temperature. *Dasyptyllus*, unlike *Ceratophyllus*, is a tropical genus and it would be of

interest to know whether *D. g. gallinulae* has acquired a fixed spring breeding-season like *C. gallinae* in the Palearctic Region.

TABLE 10

Monthly Records of C. gallinae, C. garei, and D. g. gallinulae from the Bodies of Bird Hosts in Britain*

Collectors	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
T. Clay & R. Meinertzhagen	3	1	5	16	4	8	1	22	0	12	5	0
W. H. Pollen	3	0	5	5	5	1	1	0	1	0	1	3
J. Waterston	0	0	0	3	1	5	1	0	3	2	0	0
TOTAL	6	1	10	24	10	14	3	22	4	14	6	3

* Records from domestic fowl omitted.

Sex-ratio. In all large collections of Ceratophyllid bird-fleas from nests the females are found to predominate, and there is probably a real divergence in the sex-ratio of these species. In the case of mammal fleas the sex-ratio is often estimated from the relative numbers on the bodies of the host, and in such cases the difference may be more apparent than real. It has been shown, for instance, that the sex-ratio of *X. cheopis* on the bodies of rats alters according to climatic conditions, males predominating on hot days and females on cold days (Cole, 1945), although there is evidence that in the population as a whole the sexes occur in equal numbers. Mammals are continually returning to their flea-infested lairs, nests, burrows, and runs, and thus have the opportunity of acquiring fresh fleas or reacquiring specimens that have moved off previously. In the case of birds, once the breeding-season is over the chances of acquiring or 'changing' fleas must be greatly reduced. We may therefore expect the sex-ratio of fleas on the bodies of birds to remain fairly constant throughout the year. The marked difference between the proportion of males of *D. g. gallinulae* on the bird and in the nest may in this case reflect a divergence in the feeding-habits of the sexes. There is another point worth remembering in connexion with bird-fleas. The sexes copulate freely on emerging from their cocoons, with or without a blood meal, and therefore a single female carried through the winter on the body of a host may be capable of laying fertile eggs in the nest in the following spring without the presence of a male *at that time*, since she was probably fertilized the previous spring in the nest. It has been shown that sperm is stored in the spermatheca and released when the eggs are about to be laid. It would be interesting to know how long the sperm of bird-fleas remains viable in nature. In the laboratory *Pulex irritans* has been known to lay fertile eggs sixty-five days after copulation (Bacot, 1914).

Proportion of birds infested with fleas. Another question which springs to mind concerns the actual proportion of birds which carry fleas on their bodies. This must vary according to the species. We can deduce that House-Martins and Starlings, for example, are more heavily infested than most species, and that the peak of infestation occurs during the breeding-season. The figures in Table 4 do not give us

any information on this subject, because there are no negative records available. Apparently few British flea collectors, unlike the collectors in East Africa (see p. 213), keep negative records. The relative data for nine species have been supplied by Miss T. Clay (Table 11). The infestation rate may be slightly higher than usual, since

TABLE 11

Proportion of Birds infested with Fleas
(Collected by Colonel Meinertzhagen and Miss T. Clay)

<i>Name of bird</i>	<i>Total shot</i>	<i>Total infested</i>
<i>Corvus f. frugilegus</i> L. Rook	18	1
<i>Corvus monedula spermologus</i> Vieill. . Jackdaw	36	2
<i>Sturnus vulgaris zelandicus</i> Hart. . . Shetland Starling	135	4
<i>Emberiza citrinella nebulosa</i> Gengler . Yellow-Hammer	56	4
<i>Passer d. domesticus</i> (L.) House-Sparrow	35	3
<i>Parus major newtoni</i> Prazak British Great Tit	66	7
<i>Prunella modularis occidentalis</i> (Hart.) British Hedge-Sparrow	90	6
<i>Delichon u. urbica</i> (L.) House-Martin	7	2
<i>Riparia v. riparia</i> (L.) Sand-Martin	2	1

a large proportion of the collecting was done in April and August. The monthly returns for the Great Tit (Table 12) show that in the case of this bird collecting happened to be rather more evenly spread out, and the preponderance of specimens shot in April is not so marked. This gives a truer picture of the infestation rate, but un-

TABLE 12

Proportion of Great Tits (Parus major newtoni) infested with Fleas
(Collected by Colonel Meinertzhagen and Miss T. Clay)

<i>Parus major newtoni</i> Prazak British Great Tit	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Number uninfested . . .	11	2	9	12	3	2	3	5	1	3	8	7
Number infested . . .	—	—	1	5	—	1	1	—	—	—	—	—
Total shot.	11	2	10	17	3	3	4	5	1	3	8	7

fortunately positive winter records are altogether lacking for this species. It will be seen from Table 11 that nearly 7 per cent. of 445 Passerines examined carried fleas on their bodies, and this is probably a fair estimate for the whole order in Britain. In the case of the Hirundinidae the proportion may well be greater.

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7 FEB 1952